Food Values

What they are: How to calculate them

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M. Mc. Killop

FOOD VALUES

WHAT THEY ARE, AND HOW TO CALCULATE THEM

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PREFACE

THIS little book has been compiled for the use of those students of diet who wish to undertake quite seriously the consideration of food values, and the problems involved in their investigation. I believe, therefore, that it will be welcome to teachers and demonstrators in cookery; to caterers, and to all people responsible for the daily menu in colleges, schools and other institutions; also to social workers, especially those who are working on lines similar to those in Rowntree's well-known *Poverty* and other works. Also, I hope that it will be used by many modern housekeepers, who are now well aware that scientific results and scientific method can be used very extensively even in housekeeping on a small-scale.

It is not a "War Book." The large number of useful publications on food which have been issued since the War devote much attention to the changes of price, which now vary from month to month, even from week to week, and can hardly be foreseen. Tables involving questions of price have therefore at present no permanent value; each problem of the kind can be solved only for the moment. The information which has been collected here has suffered no modification from the great world

change. Apart from any errors of my own which may have occurred, the statements will need revision only, in the first place, as the investigation of the scientific principles of diet advances, and, in the second place, as the processes by which food is analysed are improved.

At present the words "food values" are used by many people very loosely. They do not realize that they are referring to figures obtained by careful computations and comparisons, and giving complex information about each kind of food, but are content with vague statements about "much" and "more" nourishment in this or that food. They speak of the "food value of oatmeal" as if quite unaware that a food-stuff of the kind has different "values" under different headings, and can be judged, and compared with other foods, under each of them. There is no such thing as food value in the singular number. And when the different values of a certain quantity of oatmeal are known, we have yet to ask into how much porridge it is to be converted; and, further, to compare this with the amount of food needed at the moment by the persons who are to consume the porridge.

At present the inquirer who desires all this information must have recourse to somewhat costly books on dietetics and on the analysis of food; and it is then left to her to do some percentage calculations, involving decimals, to apply the facts she has gleaned to the particular problems of diet brought under her notice. This means a large expenditure of time and trouble on the

part of a busy woman while practising or teaching housekeeping, or visiting working-class homes. She may not have access to the books of reference; she may be doubtful of her unaided powers of calculation. Most often the solution of her problem in actual terms of food values is indefinitely postponed, and she is content to go on with hazy generalizations.

I have therefore endeavoured to collect in a small handbook as much information as possible on the requisites in diet and the composition of ordinary foodstuffs, for the most part in condensed and tabular form. I have then given numerous examples of the ways in which calculations are made from the tables, assuming that some at any rate of my readers are shy of decimals, and even need a little help with arithmetical problems.

The sources of the information are as a rule indicated throughout the book. But I should like to express here my special obligations to Dr. Robert Hutchison, whose book on Food and Dietetics is an invaluable help to all students; and to Prof. Graham Lusk for his two books on Nutrition. The whole compilation would still be of little value had I not possessed some, and had access to others, of the valuable American Farmers' Bulletins quoted so frequently, particularly those called *Eggs and Their Use as Food*, or by similar titles. These are widely circulated in the United States; they are simply written for private domestic use, though they include very full tables. The English housekeeper's task of providing suitable food would be much easier if we had

any literature resembling these cheap Government publications which are part of the State's activity in America. Here it has been left to a private society—the Food Reform Association—to initiate the publication of little pamphlets which aim at giving somewhat similar information, though without the tables.

Dr. I. Smedley Maclean has been kind enough to read my proofs and to make some valuable suggestions.

M. McKillop.

PREFACE TO THE SECOND EDITION

The chief additions to the text will be found on pp. 124 *seq*, in the form of notes to Chapters II, IV and VI. The subject of vitamines has been treated in much greater detail and brought up to date. New methods are given for estimating nutritive requirements of individuals in calories; also tables indicating what will constitute 100 calorie portions in various common foods. Lastly a table is given showing how to estimate the calorie and the protein value of dishes where the recipe has given the ingredients by measure, not by weight. The writer is greatly indebted to an American publication, "Feeding the Family," by Mrs. Rose, both for the method of presentment of the nutritive requirements, and also for most of the actual figures in the new Tables A and B.

BOOKS FOR REFERENCE

1. General Treatises on Diet.

Bryce, Dr. A. *Modern Theories of Diet.* Arnold. 7*s.* 6*d.* net.

Bryce, Dr. A. *Dietetics* (The People's Books). Jack. 6*d.* net.

Hutchison, Dr. R. *Food and Principles of Dietetics* Arnold. 16*s.*

Locke. *Food Values.* Appleton, N. Y. and London. 5*s.*

Lusk, G. *Science of Nutrition.* Saunders, Philadelphia. 12*s.*

Lusk, G. *Physiological Basis of Nutrition.* Milford. 2*s.* 6*d.*

Watson, Chalmers. *Food and Feeding in Health and Disease.* Oliver and Boyd, Edin. 10*s.* 6*d.*

Watson, Chalmers. *Book of Diet.* 2*s.*

2. Low Protein Diets.

Chittenden, R. H. *Physiological Economy in Nutrition.* Stokes & Co., N.Y.

Chittenden, R. H. *Nutrition of Man.* (U.S.A.). Heinemann. 14*s.*

Hindhede, M. *Protein and Nutrition.* Ewart Seymour 7*s.* 6*d.*

3. Analysis of Food.

Blyth Wynter. *Foods, their Composition and Analysis.* Griffin. 16*s.*

Tibbles, W. *Foods : their Origin, Composition and Manufacture.* Baillière, Tindall & Cox. 18*s.*

Wiley, H. W. *Foods and their Adulteration* (U.S.A.). Churchill. 21*s.*

4. General Physiology.

Bayliss, W. *Principles of Physiology.*
Halliburton, W. *Handbook of Physiology.* Murray. 15*s.*
Hutchison. *Applied Physiology.* Arnold. 7*s.* 6*d.* net.
Starling. *Principles of Physiology.* Churchill 21*s.*

5. Miscellaneous.

The Farmers' Bulletins, Reports and Year Books, published by the Agricultural Department of the United States government, contain much information on food not to be obtained elsewhere. They are for sale by the Superintendent of Documents, Washington; the Bulletins are usually 5 cents. each, but many of the earlier ones are out of print. A full list can be obtained by application to the Superintendent.

Rowntree, B. S. *Poverty: a Study of Town Life.* Macmillan. 2*s.* 6*d.*

Rowntree, B. S. and Kendall, M. *How the Agricultural Labourer Lives.* Macmillan. 2*s.* 6*d.*

Paton, D. N. Dunlop, J.C. Inglis, E. M. *Study of the Diet of the Labouring Classes in Edinburgh.* Schulze, Edin. 2*s.* 6*d.*

Paton, D. N. Dunlop, J. C. Inglis, E. M. *Study of the Diet of the Labouring Classes for Glasgow.*

Germany's Food, Can it Last. The Case Presented by German Experts. Tr. by J. Russell Wells. Univ. of London Press. 2*s.*

CHAPTER I

INTRODUCTION

Now that Economy has become a national watchword, and is likely to remain so for many years to come, there is no subject on which people more ardently desire information than on our actual needs in food. For a multitude of reasons we are all about to reduce our expenditure on food. This will be done in many cases by reducing the actual quantity, a step which may be entirely judicious; but it will be done much more usually by important changes in the diet. How can we be sure that we are not running the risk of being underfed or wrongly fed? How are we to choose among the many suggestions made, the many contradictory statements as to the food actually necessary to us, its nature and its quantity? Any housekeeper at this moment can obtain innumerable recipes, of which the chief object is to exhibit a great decrease in the cost of each new dish, compared with the cost of the old dishes in the old recipes. She can obtain an equally large number of "hints," which indicate how materials formerly thrown away can be used to contribute to the family sustenance. Occasionally estimates are given of the amount "saved" by the use of these materials, or the quantity of nutriment available in each new dish, but these numerical estimates are compiled for the purpose of recommending the hint or the recipe; they do

not form part of any scheme of adequate diet per person per day; they do little to answer the question—How can I be sure that the food I am offering daily to the people for whom I am responsible is right, in nature and in quantity, to keep up their health and strength —those national assets which have to be conserved and increased as fully as possible?

This handbook has been compiled to answer that question; not so much directly by giving model diets, as by putting readers in possession of the chief facts known at present about food and diet, in a condensed accessible form, and, as far as possible, by means of arithmetical data. It will be shown how these data can be used in working out problems for the diet of individuals and of small communities. Readers will be able by use of the Tables to answer their own questions. In particular they will be able to discover whether a given plan of feeding certain people, reviewed weekly or daily, will be approximately a sound one.

It will always be necessary, however, for them to use their own judgment finally in adopting a standard of sufficiency in diet, for as yet there is no such standard to which unanimous adherence is given. This book will aim, further, at indicating clearly what statements or figures are generally accepted, what other statements and figures are still under discussion, and will aim also at guiding readers to avail themselves of any new information that may be published.

Information of the kind is spoken of commonly as the knowledge of food values—a rather vague term. Long before the war there was a pious aspiration that housekeepers (and above all housekeepers in the making —girls still at school) should know about food values.

The idea in the minds of people, who often used this expression rather loosely, seemed to be something of this kind :—It is obvious that a pound of beefsteak contains more nourishment than a pound of strawberries. Therefore all foods can be arranged in order of merit according to the amount of nourishment they contain.

But the inquirer, looking for such a list of food values, finds the quest full of difficulties. A human being requires different kinds of nourishment. The physiologist tabulates his requirements under the three main headings of proteins, fats and carbohydrates, and states these requirements in grams. We have to convert these figures into ounces or pints of ordinary food ; and only in the case of the fats is the arithmetical process at all simple. Then we find it necessary to follow the points of a scientific discussion as to how far these three forms of food can "replace" or "spare" one another, just as we have taken the trouble to keep them carefully apart. It seems that their relation to each other must be settled before we can arrive at the knowledge of how much of each kind an ordinary person needs.

Postponing the consideration of this relation to the next chapter, we will describe here briefly the three kinds of food distinguished by the physiologist.

Fats. Fats are certainly more familiar to us than the other two. We think first of the fat from beef, mutton, pork or bacon ; then of butter and margarine ; next perhaps of olive oil, the only vegetable fat we take separately as an article of diet, and lastly of the various nut butters and vegetable margarines now to be obtained. These last forms of fat have until recently been used chiefly by vegetarians, but now the fact that they cost less than the others is recom-

mending them to every one's notice. We do not find it difficult to believe that fats form a separate category in food-stuffs. This is partly because we are accustomed to buy and to use them separately. Fats and oils are found naturally, however, distributed in minute quantities through many animal and vegetable foods; as for instance in milk, cheese, nuts, yolk of egg, and even in lean meat. We look for fat in animal rather than in vegetable food, in which it occurs to a less extent.

Carbohydrates The name carbohydrate signifies to the chemist a compound of carbon, hydrogen and oxygen, with the two last elements in the same proportion as that in which they occur in water. Fats contain the same three elements, but less oxygen in proportion than the carbohydrates. The name carbohydrates is still used in treatises on diet, but it is in one way unfortunate, because certain compounds which come under the chemist's definition of carbohydrate (notably cellulose) are very little use to us as food. The food-stuffs classified as carbohydrates are chiefly the sugars, and starch, which is closely connected with sugar. They are now often termed the saccharoses or saccharides.

There is more than one kind of sugar. Beet and cane sugar show no appreciable difference in composition at all; but the sugar in fresh fruit (found also in small lumps in dried fruit such as raisins) is different from cane sugar; so is the sugar occurring in milk. There are yet other kinds. Our chief source of all sugars is from plants, which are continually manufacturing it from their mineral food, gaseous and liquid. But they primarily manufacture starch, and store this in seeds, roots, stems or tubers, because it is insoluble in water. It is con-

verted into sugar when it must travel to various parts ot the plant, and must be soluble in water to be carried from one place to another. This process of converting starch into sugar is also effected when the animal or human being digests starch; but the converse process of changing sugar into starch, necessary to the plant, is not a part of our digestive[1] activity, which must always aim at making matters soluble.

Briefly, we may take our carbohydrate food as starch or as sugar, only in the former condition it gives more work to the digestive organs. But it is more palatable to most people, especially to take in quantity, probably because of the absence of very definite taste. It is the chief constituent, by weight, of the solid portion of bread, potatoes, oatmeal, rice and peas. Practically all our starch comes from vegetables, also all our sugar, except that in milk, and in honey—if we count honey as an animal product. Vegetable foods bring, in addition, some quantity of cellulose, varying according to the special preparation given to the food, and also with the part of the plant selected. Green vegetables, and most fruits, especially those with small seeds, contain a good deal; whereas a substance like white flour contains very little. Cellulose is the substance of which the plant cell-wall is made; one sees it in almost pure form in white paper or in cork. Although it is a carbohydrate from the chemist's point of view (and also formally included under the term saccharide because it is related to starch), it is usually indigestible, and is finally expelled from the system. The cells of animal tissues have no cell-wall, and therefore animal food contains no cellulose. It also contains as a rule no starch.

[1] See note 2, p. 57.

Starch, when strongly heated, is converted into dextrin, another carbohydrate, which is digestible, being soluble in water, whereas cellulose is completely insoluble. We are familiar with dextrin as it gives the brown colour to the crust of a loaf. In the pure state its solution in water forms gum or mucilage.

Proteins. It is more difficult to realize the nature of a protein than that of any other constituent of food. The nearest substance to pure protein that we are likely to see among ordinary foods is the coagulated curd of milk, out of which cheese is made. This consists chiefly of the protein called casein. Purified from other material, and then quite tasteless, it forms the basis of medicine foods such as Plasmon and Protose. But we need not think of protein in these rather remote and expensive forms. The chief part of muscle, which we know as lean meat, is a protein called *myosin*. The part of flour which is not starch, known as gluten, consists of at least two proteins—*glutenin* and *gliadin*. White of egg, often known as albumin, is almost pure protein. Peas and beans contain *legumin*, which is very like myosin.

It is for the chemist to tell us how these proteins actually differ from one another, and their composition is still under investigation. Each protein may be said to be a complex combination of several chemical compounds allied to each other. All of these are composed of carbon, hydrogen, oxygen, nitrogen, usually sulphur, and occasionally phosphorus as well. Professor Lusk has suggested, in a very interesting lecture,[1] that a single protein consists of a group of these compounds, somewhat as a word consists of letters; and,

[1] Lusk. *The Fundamental Basis of Nutrition.*

like letters, the compounds can be combined to give many different proteins, like different words. It is now being discovered by experiment which proteins are more valuable to us than others. But it is quite certain that the best diet should contain a great variety of proteins, so that, if we carry on Lusk's simile, we should have enough words to make sure that the entire alphabet is represented. Meanwhile, for most purposes all proteins are counted together, and the "protein content" of a food given as one figure, without distinguishing which are more, which less valuable.

The dietetic view of food. The view of our food taken by a dietetician will become clearer to us if we compare it with the view of a mistress ordering a dinner, and that of a cook preparing it. Let us say that the mistress orders a stereotyped pre-war meal of this kind:—Boiled cod and anchovy sauce, roast chickens with forcemeat and bread sauce, potatoes, sea-kale, apple pie, custard, and a cheese dish as savoury. She surveys her dinner under its separate courses by way of classification. The cook passes it in mental review, and, after noting the simple items to be obtained, such as the fish, the chickens, the sea-kale, the potatoes, apples and cheese, she analyses further something after this manner.—Butter wanted for three sauces (anchovy sauce, bread sauce, white sauce for sea-kale), also for the pastry unless some other fat is used, a little also for the cheese pudding. Suet for the forcemeat. Milk for the sauces, and for the custard. Bread for forcemeat and bread sauce, also for some toast under the sea-kale. Flour for two sauces, for the pastry, and for the cheese pudding. Eggs for forcemeat, custard and cheese pudding; sugar for apple-pie and custard. Now how much is wanted

of each altogether ?—This analysis of her review is not intended to be exhaustive, but only to show that she surveys the proposed meal under different categories from those of her mistress. Next comes the dietetician, the person interested in the meal as providing proper diet, and rearranges every dish suggested under the fresh headings of proteins, fats, carbohydrates. He will probably start with the cook's analysis, and convert that into his own headings. How exactly to do this is shown in the Tables in this book. The method followed is, obviously, to split up again meat, vegetables, milk, flour, eggs and so on into their constituents as he sees them, and estimate the whole quantity of these constituents in the meal.

Lastly, a chemist might take the analysis just made by the dietetician, and rearrange proteins, fats and carbohydrates under the headings of the chemical elements. He would split up proteins into carbon, hydrogen, oxygen, nitrogen ; fats and carbohydrates into carbon, hydrogen and oxygen, indicating also the small quantities of other elements which appear in the foods. His chief concern would be to estimate the carbon and the nitrogen supplied in the meal.

Practical people, who wish to provide and prepare meals with some judgment as to their dietetic value, need the power of surveying the meals according to all these categories in turn, although to follow out the chemist's at all thoroughly needs considerable knowledge of physics and physiology as well as of chemistry. They must realize that the problem is a scientific one, and lays many "ologies" under contribution. The last one to be remembered is Psychology, as important perhaps in feeding people as it is in teaching them. It is one thing

to provide six people with a dish costing 6*d.*, in the manner of Mrs. Beeton and all worthy cooks after her; it is quite another to make sure that they are each going to consume their penny portion. "How if he will not?" is the final problem of the home caterer.

In concluding these introductory remarks it is necessary to remind the reader that the scientific study of nutrition, particularly by means of experiment, is a comparatively new one, and that much work has still to be done. Every year new discoveries are being made, and activity in research of the kind is likely to be promoted rather than discouraged at present. In consequence, although so much work of incstimable value has been done, every investigator naturally has still an open mind, and is ready to modify his first conclusions if there is sufficient evidence for him to do so. Therefore students of our requirements in food must keep their minds also open; and keep their eyes open to acquire new information from reliable sources. Meanwhile many a student may be a woman of action; she has to be feeding people while questions hang in the physiologist's and chemist's balance. She must act on the present stock of assured knowledge.

Unfortunately many of the small pamphlets on food are written to recommend or vindicate some theory of diet, or to prove to the hilt the ease with which expenditure on food can be halved, especially by dispensing with certain items. Any treatises containing absolute dogmatic statements about the value of foods, with conclusions drawn from them after the manner of a mathematical demonstration, are to be distrusted. A writer with some contention to support is quite likely to have seized favourable figures without inquiring too

closely into them, and may give some that have been superseded, or some that are not yet fully established.

Figures given for the analyses of different food stuffs are usually averages from a large number of samples. An actual piece of bread or meat may differ quite noticeably from the average. We cannot therefore work out our arithmetical additions with an accuracy similar to $2+3=5$.

In the same way if figures are given for the requirements in food of an average man of known weight and occupation, a particular man of the type may be found who will do better on a somewhat different amount. We must all learn to work by averages if we are to make use of any tabulated and generalized information on nutrition, and learn to make afterwards some judicious allowance for slight differences in the actual problems before us. We shall find ourselves prone to each of the two opposed mistakes in turn, if we are not watchful; one the exaggeration of individual differences, the other the adoption of the average figures in a hard and fast way, as if they came from the multiplication table. For instance, people usually make far too much of departures from the average in personal traits about eating; whereas, if they see a figure giving the average percentage of fat in cheese, they are apt to pigeonhole their information in their brains as if it were applicable to any cheese whatever.

NOTE

It may possibly be of use to add a note on the use of percentage numbers, merely as a matter of arithmetic. Suppose it is desired to ascertain the composition of a sample of food. Small portions of it may be assigned to different workers at the same time, or used by the same person at different times, and chemical methods used to find the amounts of protein, fat, sugar, etc., in each

piece. As the original weights were different, these separate amounts will come out different. How can they be compared, and combined into one average result? We get an average by adding together strictly comparable results, and dividing the sum by the number of results. But these results are not comparable as they stand. We might call the original weight in each case 1, and say $\frac{1}{4}$ or $\frac{1}{6}$ was fat, and so on. But fractions are very awkward, because they are difficult to add together; that is, vulgar fractions are. Decimal fractions are much more easily added. But if we use them, i.e. tenths, hundredths, and so on, we might as well take 100 as the original weight instead of unity. Then we shall have whole numbers in place of tenths and hundredths, and begin decimals only for thousandths.

To take an example, of two pieces of meat one contained $\frac{1}{4}$, the other $\frac{1}{6}$ of fat. In decimals these figures would be ·25, ·167. In percentages they would be 25, 16·7. The average of the two would be $\frac{41 \cdot 7}{2} = 20 \cdot 85$. The last figure (5) is the ten thousandth part of the sample of meat, and therefore might be neglected unless very large quantities were in question. Percentage analyses are often given only to one decimal place, and that will be enough for computations on a small scale.

Some of us, who had never been taught to use decimals in practical life, used to be afraid of them because of their apparently ungovernable propensity to "go on for ever." No practical investigator has any time, nor has he occasion, to go with them. He is aware that each succeeding figure has, by its place, only $\frac{1}{10}$ of the importance of the one before it, and that therefore the figures soon cease to affect practical issues.

CHAPTER II

OUR NEED OF FOOD. HOW THE DIFFERENT KINDS SATISFY IT

Food compared to fuel. THE food given to a human being is very often compared to the fuel supplied to a steam engine; an analogy giving direct sanction to the slang expression 'stoking,' for partaking of a meal. But there is a little confusion in the comparison. It is rightly believed that food keeps us warm, it creates heat in us in some way. Now, though fuel creates heat in a steam-engine, it is not put there for that purpose, but in order that the engine should perform work. We know it is the heat that produces the work. The human body needs first to be heated, or rather warmed; and secondly to be able to do work. There is a large amount needed to keep up the proper body temperature, and a variable extra amount according to the exertions made by the person. The work done by the body is not only that which the individual chooses to do, such as walking, lifting or otherwise using the muscles; it includes also involuntary exertions that are always going on; such as the beating of the heart to propel blood, the expansion of the lungs, action on the food during digestion, and so on.

An engine also may be put to do work of various kinds. But all kinds are alike in this, that each is

produced by the heat in the engine, and that this heat comes from burning fuel. Is our food then burned like fuel? The process is practically the same chemically; food is, finally, for the most part oxidized by the oxygen taken into the lungs; only the action is more gradual, and sets free heat at a slower rate.

Food measured in terms of heat. It is most important to realize that heat gives power of doing work. This power is known as energy. There are many ways of measuring energy, as it can always be estimated in terms of the work done, of whatever kind that may be. But another way is to measure it in terms of the heat taken to produce it. This last way is by far the best for the estimation of the needs of the body. If we express them all in terms of heat it does not matter that part of these needs are for heat itself and part for energy produced by heat.

The measurement of heat. But how do we measure heat? In ordinary life we do not, as a rule, measure it at all; we measure temperature. We speak of 60° Fah. as the temperature of a room, or of 212° Fah. as that of boiling water. However, we know quite certainly that one quart of boiling water holds more heat than one pint, without putting them to a test, such as finding which would warm a bed best, when placed in a hot-water bottle. Probably we can also realize without proof that a quart should contain twice as much heat as a pint at the same temperature. Further, we can comprehend that a quart of water which is 100° Fahr. warmer than a bed ought to warm it about twice as well as a quart only 50° Fahr. warmer.

If we may be allowed to assume that these relations hold, and can be proved mathematically accurate, we

shall understand that heat can be measured by the amount taken to heat a certain quantity of water a certain number of degrees. This method is rather more convenient than expressing it in the reverse way, as we did in speaking of the use of a hot-water bottle. Then we were considering the heat given off by a quantity of water when cooled through a number of degrees. This is exactly equivalent to the heat originally taken to raise the water to that degree of heat. For accurate definition the weight of water, not the volume, is fixed, and usually the temperature is measured in degrees Centigrade, not Fahrenheit.

A convenient unit for measuring heat is the amount taken to heat one kilogram of water one degree C.; or, more precisely, to heat it from 0° to 1° C. This unit is called a Calorie, but with a capital letter, because it is known to scientific men as the large Calorie. The small calorie is the unit used in delicate heat experiments with small quantities. It heats only one gram of water through one degree, not a kilogram, which is 1,000 grams (about $2\frac{1}{4}$ lbs). The volume of a kilogram of water is about $1\frac{3}{4}$ pints. A Calorie has also been roughly defined for practical people as the heat which will raise 1 *lb.* of water 4° *Fahr.*

Fuel value. Our requirements in food can then be stated in Calories or in "Fuel Value" for each person per day. This is because food resembles fuel; and the value of what we eat can be measured by the amount of heat it can produce in the body. We need take no notice of the fact that the combustion takes place slowly and at a comparatively low temperature; or of the fact that some heat goes to keep up the temperature of the body (98·4° Fahr.), while

the rest is used up by our doing muscular work, voluntary or involuntary.

One great advantage in regarding food merely as supplying Calories of heat is that, for any given kind of food, a figure can be given for the exact amount of Calories produced when one gram, or one ounce, or one lb. of it undergoes combustion in the body; and therefore the effects of the different kinds of food taken can be added together into one total.

Food for body-building. We must now consider food in an aspect in which it is different from fuel. When an engine shows signs of wear in any part, it must be stopped and repaired before it can work effectively again. The human machine must keep on going if it is to continue to exist; voluntary work may be reduced to a minimum, but involuntary work, and the production of heat, must continue. The only method by which the body can replace—from outside—the wear and tear of its material is by the consumption of food. This is also the only means by which it can grow.

All foods are not equally valuable for the purpose of body-building, that is for the two processes of replacing old tissue, and creating entirely new tissue. We have now to distinguish different kinds of food, surveying them under an aspect in which one cannot replace another.

Proteins as body-builders. The most important constituent of food for the purpose of body-building is the substance referred to in the last chapter as protein,[1] or

[1] Mulder, in *Vegetable and Physiological Chemistry*, 1845, says that the name protein is given to a definite substance "because it is the origin of so many dissimilar bodies, and is itself a primary

the proteins, if we prefer to use the plural. We saw that proteins formed the chief part of flesh or muscle, i.e. of lean meat, though they could be obtained from many other foods. It seems obvious, however, that lean meat should be capable of forming new tissue, as it is natural that flesh should replace flesh. It will be equally obvious that milk can make new tissue, as babies and young animals rapidly increase in weight while it is their sole diet. And the material in an egg must be tissue forming, as during incubation the chick is formed with its aid, by the growth of the tiny embryo which is so small a proportion of a fresh egg.

Proteins as fuel. But it will suggest itself after a moment's reflection that flesh at least, can also be used as a source of heat and energy. Suppose persons are undergoing actual starvation. They still keep warm, though perhaps with difficulty, and they are not incapable of motion. Where does their energy come from? It is true that any fat which may have been deposited in the body gradually disappears; but the tissues themselves also waste away, more rapidly in a thin person than in a fat one. The actual flesh of the body can then be used to give energy, so it seems clear that any meat we eat can do the same. Meat and all the other forms of protein we get in our food will give energy when oxidized, just as carbohydrates and fats do. It is nevertheless extravagant to get one's heat and energy from protein; extravagant in the housekeeper's sense, because food that contains a lot of

substance." This is no longer the scientific meaning given to the word, but shows that its importance lay in the readiness with which it undergoes chemical change to form material important in life processes.

protein is generally expensive, and also from the view of the body's economies, if protein is the only food that builds up the tissues. The other kinds of food are therefore often referred to as "protein-sparers."

Water essential for new tissues. Is protein the only essential for replacing body tissue? Water is certainly essential; as about two-thirds of every tissue consists of this substance. But we are not put to any trouble in obtaining it, as most of the food we eat contains as much as this, if not more; and we naturally take drink of some kind with any food which is rather dry.

Mineral salts essential. Further, practically all our food contains some mineral salts, which are equally necessary for the construction of tissue. The easiest way to find out what mineral constituents exist in any sort of food is to burn a sample of it as completely as possible. When all the black charred material has been burned away the small quantity of white or grey ash remaining is the mineral part of the food. It consists generally of potassium, sodium, calcium, iron and magnesium, occurring as phosphates, carbonates, sulphates and chlorides. The proportion in which these are present, and the actual quantity present, vary very much in the different sorts of food. So it often may be important for particular reasons to know in which mineral constituents some special food is rich, and in which it is poor. But if we consider the constitution of animal and vegetable stuffs generally, and compare it with that of our own tissues, we find that the mineral materials used are very much the same all round; the same substances are needed, speaking broadly, by every sort of living matter. For instance phosphorus and sulphur enter into the constitution of protoplasm

(living matter) itself ; salts of potash, soda and iron are essential to the processes by which life continues ; and lime or silica are the materials from which hard resisting structures are built.

Plants, animals and human beings are then continually passing these mineral salts on one to another. But it must not be forgotten that when we obtain them naturally in our food they are not in the simple chemical form in which they are in ash, they are in complex combination with organic material; and it is these combinations with which our digestive system is prepared to deal. It would not be at all the same thing for us to eat the mineral ash, it might be quite useless to us, though it cannot be said dogmatically that it is certainly useless, considering that we take, and require, salt in the mineral form. Plants, on the other hand, can use this mineral ash, if it is returned to the soil, and there passes into solution. It forms good manure, i.e. plant food, but is not good animal food.

However, the main point about the minerals in our diet is that we do get all that we need of every necessary chemical salt in an ordinary mixed diet. In fact we usually get more than we need, and the body has to excrete the surplus. It is only when the diet is for any reason very limited in range, and many varieties of food are excluded, that trouble begins for want of certain mineral constituents.

Vitamines. But the difficulties caused by limiting diet to one or two forms of food are by no means ended when we have discussed mineral salts. In recent years much experimental work has been undertaken in feeding exclusively on some selected form of food, very often in the purest form obtainable,

or even made artificially. The subjects of experiment have been human beings and animals, notably small ones, such as mice and rats. Much attention has been drawn to results indicating that there is some other factor, besides those mentioned, necessary to growth, if not always to actual repair of tissue. No summary of these results is yet possible, as new and important observations are frequently published.

An instance of this kind of observation is that of an experimenter who fed mice on the purified proteins from milk and egg with starch from potato and wheat, and oleo-margarine equally purified, 'together with the correct mineral salts. The mice lived and produced offspring, but these were difficult to rear, and did not reproduce at all.[1] It has also been noted that rats which continue to grow when butter is their chief food, cease growth when fed with pure lard. The study of certain diseases has given indications in the same direction. The best known case is the disease of *beri-beri*, incurred by persons living almost exclusively on polished rice. When the rice grain is prepared for use by modern machinery, every vestige of the husk is removed, and the grain is said to be polished. This is not the case when it is prepared in a more primitive way. Coolies in China and Japan who live on machine-prepared rice have developed a disease unknown to their forefathers. The chief symptom is an increasing weakness in the limbs, followed by emaciation and death. If taken in time the disease can be cured by substituting unpolished rice as their daily fare, or by changing the diet altogether. Yet it has

[1] This early work on the subject dates from 1902. See Lusk *Science of Nutrition*, p. 108, ed. 1909.

not been established that any definite mineral constituent has been removed in the husk.[1]

Something resembling this was observed by two investigators who fed some rats on white bread or white flour, some on whole meal bread, or flour, as their sole food. In the former case death followed after some time. As will be seen by referring to the Tables, there is no great difference in nutritive content between the two. There seemed to be something necessary to life in that part of the husk of the wheat grain which appears in whole-meal bread, and not in white.[2]

Vitamines always present in ordinary diet.

Readers must remember that nevertheless there is no risk whatever of ordinary people dying or even becoming enfeebled by the use of polished rice or white bread; because neither of these foods is likely to be their sole diet; and the necessary substances will make their appearance in the usual mixed diet. Also that people do not thrive on any highly purified artificial form of diet, but can be brought into a normal condition again by adding fresh milk, meat, peas, or some "fresh"—not preserved or elaborately isolated—food to their daily fare.

The name of *Vitamines* has been given provisionally to these necessary substances. They evidently exert an influence quite out of proportion to the quantity

[1] The material removed in polishing is sometimes sold as "rice flour," and is actually a more valuable food material than rice itself.

[2] Hill and Flack. "Nutritive Value of White and Standard Bread," *British Medical Journal*, May, 1911. The criticisms on their paper in the same journal should also be read; and particularly the suggestion that the missing substance may be identified by further work as a compound of phosphorus, and not precisely a substance of the nature of a "vitamine."

that is present. It has been suggested that they are not actually food but "produce a harmonious interaction between materials in the food and their host."[1] Agents of this kind are called in scientific language, catalysts or hormones, but the less technical term "accessory factor" seems the best for general use until more is known about them. It appears that they exist primarily in vegetables, and pass from them into animal tissues.

Protein the chief need. After this brief survey of the material necessary for building up tissue, it will be established that what we have to secure in diet, for this special purpose, is a proper supply of protein.

From what part of the food will this come? The obvious sources are meat, including fish, milk and eggs. We can add cheese as a product of milk, but not butter. The curd which makes cheese consists of practically all the protein in milk, whereas in making butter the protein remains for the most part in the skim milk.

But all food consisting of vegetable material, without any elaborate separation and isolation of certain products—that is to say all kinds of seeds, roots, tubers, stems, leaves, fruit as we eat them contain some protein, though the quantity is very variable. Generally speaking, seeds (those which we select as food), contain most, seeds such as peas and other pulses, nuts, and the cereals; whereas green vegetables and fruit contain very little. Sugar, on the other hand, being carefully isolated from the plants in which it occurs, contains absolutely no protein; starchy preparations like cornflour and arrowroot contain practically none; and

[1] Lusk. *Fundamental Basis of Nutrition.*

the same may be said of most purified forms of fat and oil.

The full list of materials for building up tissue is then as follows :—

I. Proteins. Present in nearly all our diet, but in widely varying proportions.

II. Water. Present in all, usually in large proportion.

III. Mineral Salts. Present in very small porportion.

IV. Vitamines [Provisional name for certain accessory factors].

It is believed that the presence of a carbohydrate is also essential in some way to the production of new tissue. Except for this proviso, the two other forms of food, fats and carbohydrates, are absent from the list.

Fuel values of the three foods.

We must now revert to that primary use of food, for which all three kinds serve—to produce heat and energy. The different forms produce this in different quantity, according to their chemical composition. Proteins are not entirely combustible ; the nitrogenous part is separated, with a certain amount of carbon, hydrogen and oxygen, and the non-nitrogenous part may be considered as combustible like the other forms. This portion is comparable to a carbohydrate in the quantity of heat it produces during combustion ; whereas the fats produce, weight for weight, more than twice as much. The quantities have been carefully calculated many times over from experiments with a calorimeter, and the generalized result is that—

1 gram of	Protein	in combustion	produces	. 4·1	Calories
1 ,,	Fat	,,	,,	. 9·3	,,
1 ,,	Carbohydrate	,,	,,	. 4·1	,,

In ounces this statement takes the form—

1 ounce of	Protein produces	. . . .	116 Calories
1 „	Fat „	. . . .	263 „
1 „	Carbohydrate„	. . .	116 „

The requirements of an individual in Calories and in Protein will be the subject of the next chapter. In this one we have considered briefly our supply of food under several headings:—the three just mentioned above, mineral salts and water. Is this classification exhaustive? Are any well-known ingredients of ordinary food omitted? Several will no doubt have occurred to readers, if only such obvious ones as pepper and mustard. There are many such ingredients of diet very important to appetite, and through appetite to digestion. There are others which act as stimulants to the nerves. These substances are not food, if we mean by food some substance that produces heat, or goes to build up tissue. But most of us would lose a great part of our interest in food if they were not there. Substances of this nature are—

Condiments and stimulants.

1. Nitrogenous compounds which are not proteins, but give the pleasant flavour to meat and meat extracts.

2. The acids and "essential oils" found in fruits, particularly in the juice, giving flavour and perfume. For instance, the juice of a lemon contains several acids; the rind contains a non-acid essential oil which is separated as "essence of lemon." Under the same heading we may mention the strong-tasting constituents of savoury herbs and flavoured seeds like carraway and anise.

3. Pungent compounds such as occur in mustard, cresses, horseradish; also in pepper and other spices.

4. Stimulants such as are contained in tea, coffee and cocoa; which, when isolated, approximate to the nature of medicines rather than food.

These substances are, like foods proper, composed of carbon, hydrogen and oxygen, with occasionally nitrogen and sulphur as well, but those that are nitrogenous cannot be transformed into body substance. The others, though they may finally be broken up and oxidized, are so small in actual quantity that their products of combustion are negligible and do not give any calculable food value to the original material. But many, like the vegetable acids, serve definite purposes in digestion, and in helping the action of the digestive glands.

Alcohol. As we have laid so much stress on the actual combustion of food in the body, we cannot evade the difficult question whether alcohol is a food.

Without any discussion of the other effects produced by it in the body it is a fact that if alcohol undergoes complete combustion in the body, it contributes energy in Calories to the amount computed from its chemical formula. Only a small quantity daily, however, will undergo complete combustion; if more than this is taken, the alcohol is not completely burned, and other results ensue.

See p. 134 for supplementary note on fuel value.

See p. 134 *seq*, for note on Vitamines.

CHAPTER III

THE NUTRITIVE REQUIREMENTS OF THE AVERAGE MAN

We are now to arrive at a definite statement of the amount of nutrition required by the body daily, first in terms of Calories for the whole of the food needed, and secondly the amount of protein, expressed in grams or ounces, sufficient to replace the wear and tear of the tissues and to allow for growth.

By what method has it been possible to make numerical statements of this kind? Physiologists have had three ways of attacking the problem. The first is to estimate the in-coming and the out-going, if the body remains of constant weight. The whole of the material excreted by the lungs, the skin, the kidneys and the bowels, can be measured and analysed. Excepting the refuse of the food, the out-going substances are the products of all the combustion that has gone on, and of all the breaking-down of tissues. Close study has also been given to the excretions during starvation, and during extra severe labour. These researches all form part of the investigation of Metabolism. The meaning of this word is the changes produced in material from outside by the action of living cells, whether the material is built

How the figures are obtained.

Metabolism.

up into some more complex substance (anabolism) or broken down to a simpler one (katabolism). This small book cannot make any pretence to treat of metabolism, nor is the writer competent to do so. Yet any one who wishes to study nutrition properly must devote some considerable time and attention to this aspect of the subject, even though it entails some preliminary work in physiology and chemistry. We shall not venture here to touch upon this very large domain of knowledge and speculation, involved in the investigation of what becomes of the food that is eaten.

The second method of ascertaining nutritive requirements is to try experiments in diet on men and animals. These experiments are usually carried on under conditions such that the excreta are all examined, and quantitative results obtained; so that the work often throws more light on metabolism than anything else. But often there are simple conclusions with regard to the weight, health or activity of the animal which give direct information on diet.

The third way is to collect statistics concerning the actual food taken daily by people in different climates doing various amounts of muscular work, to tabulate and compare these. It is assumed that the average person who is able to obtain the food for which he experiences need will eat about the right quantity, and select about the right ingredients to keep himself "fit"—that is, healthy and strong enough for work; although it is true that medical practitioners have much evidence to the contrary. Nevertheless figures obtained in this way have great weight and value, if they are founded on a sufficiently large number of cases. We shall give a general survey of the figures in this chapter, and then

give them, in a better form for comparison and choice, at the beginning of the Tables in Chap. V.

Calories necessary. The number of Calories necessary daily for the normal average man is by no means fixed and invariable. It depends first on the area of the surface of the body, and secondly on the amount of work performed. It will be noted that it is the surface of the body, not its weight. This is because the chief part of the heat lost by the body is from the surface, whether covered or uncovered. Estimation by weight instead of surface will give a fairly approximate figure as a rule. Children must be allowed more, because the area of the surface of their small bodies is greater in proportion to their weight than it is in adults. Also a thin person loses heat more rapidly than a stout one, because he has proportionally more surface. But the greatest variations in the number of Calories will be caused by the amount of voluntary work done.

An average man is considered to weigh 70 kilograms, or 154 lb. When living a sedentary life he needs about 2,500 Calories per day, i.e. about 35 per kilogram of weight. The number will be reduced to less than 2,000 if he is resting in bed, to very little over 2,000 if he sits still in a chair and takes no exercise. The same person doing moderate physical work will need 3,000 Calories.

This quantity has been fixed by many authorities, both those judging by statistics and those from physiological evidence, and is usually given as sufficient for an ordin ary artisan. People who do strenuous physical work out-of-doors want quite 3,500 Calories, as may be seen in an interesting collection of farmers' dietaries in the United States, Mexico, Finland and Italy, made by

Prof. Atwater.[1] Much larger numbers are quoted for athletes, according to their exertions; up to 8,000 Calories for a lumberman in Maine, and 9–10,000 for a rider in a long bicycle race. These figures will not be of much avail for ordinary use. The following may be of interest as indicating what sort of difference muscular work makes: An average man consumes about 160 additional Calories in walking 2·7 miles in an hour along a level road. To climb a hill 1,650 ft. high he needs 407 additional Calories. An expert bicycle rider working hard is calculated to use about 530 extra Calories per hour.

Atwater states 3,500 Calories as the daily need of an ordinary labourer, whereas most authorities give him only 3,000. The former figure has been used by Rowntree in *Poverty*, his investigation of the life of the working classes in York, and also by Paton and Dunlop in their dietary studies in Edinburgh and Glasgow. Dunlop made observations himself on the work and diet of prisoners in Edinburgh. Probably the chief reason for this discrepancy is that it is impossible to define "moderate" muscular work, and to distinguish it quantitatively from "strenuous." But it will be seen below that the United States standard of diet tends to be higher than other countries in various ways. The severer climate in Edinburgh may also increase the estimate for the total number of Calories.

Soldiers are naturally given a larger allowance for the open-air irregular life during war time, or during manœuvres, than they are for garrison life.

It should be mentioned here that some modern writers,

[1] See Lusk, *Science of Nutrition*, Chap. IV. for this table and a full discussion of the subject.

who, as we shall see, advocate a diet rather low in protein, advise at the same time an increase in the total number of Calories customary; i.e. that one should take more carbohydrates and fats than are necessary to make up the usual number. Others are contented with a lower allowance of total Calories as well as of protein.

Probably most sedentary men of the professional type, and of average weight, consume naturally food equivalent to 2,500 Calories, or little more.

Requirements in protein. What is the quantity of protein required daily by the average man weighing 70 kilograms? It has been established by many experiments that the quantity is not directly influenced by the amount of muscular work performed. Therefore it would seem that a number could be quoted more readily than that for Calories. But the matter is beset with other difficulties, and, up till now, is far more in the region of controversy than the consideration of total Calories. A few preliminary remarks may illustrate the difficulties.

1. The number to be determined is not the actual physiological minimum upon which life can be sustained, but what has been called the optimum, upon which the body will best perform its functions, keep each organ healthy and well developed, and be able to stand a sudden strain.

The optimum amount. Too large an allowance of protein throws great work on certain organs for its chemical transformation and elimination. It is expensive in the body economy, as well as being usually so in the household economy. Protein, as such, cannot be stored in the body for future use. The main difference in the controversy as to high or low protein allowance turns to a large extent on the point whether the common usage of mankind in temperate

climates has led them naturally to the optimum, or to some excess in protein which is gratifying to the appetite.

The digestibility of protein. 2. It should be clearly stated whether the quantity fixed upon as most suitable is the protein actually contained in food, or that actually digested. The digestibility of the various kinds differs (see Tables). As a rule, the former is chosen and is, or should be, referred to as the "crude protein" allowance. In converting the protein from a mixed food into the digested quantity, 10 per cent. is often subtracted.

Method of estimating it only roughly approximate. 3. The method still adopted to calculate the percentage of protein in a given food is to estimate the percentage of nitrogen present (by analyses which have been made very close and accurate, it is true) and to multiply by a certain factor to indicate protein. In this way the small quantities of nitrogenous compounds which are not proteins are included. Formerly gelatin was included until it was established that it was not a true protein, but could only be classified as a protein-sparer, with calorific value. Even yet different kinds are not distinguished in the result of analyses. As scientific knowledge of the differences amongst proteins increases it is probable that there may have to be some distinction; and modified forms of analyses may become possible. At present the figure for the actual protein content of a food leaves something to be desired in exactness.

Protein optimum. From about 1865 onwards physiologists have made numerical statements about the amount of *nitrogen* there should be in the daily diet, and have made investigations and experiments to establish the quantity. But since then so much pro-

gress has been made in the knowledge of what the combinations of nitrogen ought to be, and also in the method of determining the quantity in a given food, that modern statements of a more reliable nature may be said to begin with that of Voit published in 1881. It was the result of many years' study of the actual diet of German people, chiefly in Munich, and also of much research. The figure he gave was 118 GRAMS OF PROTEIN, about 4¼ oz., for a man of average height and average work. [Other workers in Germany, England and other parts of Europe concurred very nearly. It was customary then to allow more for strenuous muscular effort (as this was considered to use up body tissue directly). Although, as we have said, the connexion is now shown not to be a direct and measurable one as it is in the case of Calories, it is nevertheless still usual to allow some increase for athletic efforts. The main reason is that protein increases, indirectly, the production of heat in the body.]

But to return to Voit's standard, as it has been called. In 1896 Atwater published his first results of dietary studies in the United States, and fixed 125 grams of protein as necessary. Dr. Dunlop in his investigations on Scottish prisoners gave 130 grams as the most suitable number.

Rowntree in his *Poverty*, already mentioned, took Atwater's 125 grams as the minimum daily amount of protein for working-class efficiency, and, as late as 1908, the Paton-Dunlop Studies of Diet of the Labouring Classes in Edinburgh and in Glasgow were based upon Dunlop's estimate of 130 grams.

Low protein diet. But in 1904 Chittenden published his studies in nutrition, in which, as the result

of many striking experiments, he concluded that efficiency could be maintained on as little as 50 or 60 grams of protein daily. At various times in the nineteenth century isolated experimenters in diet had tried to show by personal experience that a much lower protein diet was compatible with health. For instance, as early as 1829 an American named Sylvester Graham advocated a vegetarian diet of this kind, which produced, simultaneously with an admitted gradual loss of body weight, great increase in bodily health and appetite. (Graham also first introduced the use of a whole-meal flour, still known in the United States as Graham flour). The study of the diet of strong labouring men in tropical countries, notably of Chinese and Japanese coolies, led many observers to doubt the necessity of so much protein as is the custom in other countries; it was also urged that the poorer labouring classes in these temperate countries certainly have not during the past centuries had anything like the amount accepted by the authorities. The American households studied by Atwater were certainly well fed; he contended that this good feeding was necessary for well-being. Voit, and still more Voit's followers, admitted that the consumption of meat in Munich, where most of his statistics were obtained, was beyond the average. They believed that a smaller quantity of protein might be found sufficient, and were not concerned to find that the German soldier's daily rations contained only 98 grams of protein. Voit considered excess in protein wasteful and unnecessary. Altogether the tendency of recent physiologists also is to bring down the optimum amount to something a little under 100 grams, and to admit the possibility of carrying on a fairly active healthy life on amounts

between 50 and 70 grams. (It is always admitted that in the summer the daily amount of protein should be lessened, because of its secondary effect of increasing heat production in the body.) A recent Danish writer (Hindhede) is stronger than Chittenden in the conviction that about 70 grams daily is ample. An interesting series of experiments was carried on recently in the Laboratory at University College, London, whereby it appeared that a set of male workers there, professors and students, consumed on the average 93 grams of protein per day, while in ordinary health and subsisting on their ordinary diet. The last word of importance on the subject at this moment is to be found in the Germans' investigation of their full resources in food during the War.[1] After an admirable brief summary of the present state of knowledge on the necessary amount of protein, the German scientific authorities state their conviction that most people "can manage" with 70 grams digestible protein,—80 grams crude protein. But with every desire to put the figure low they wish also to be on the safe side, and not to advocate too great a change in the national diet. So they finally adopt 80 grams digestible, 90 grams crude protein as their minimum. There is however some confusion in this part of the investigation, for the 80 grams are finally estimated as crude protein, not as digestible. Thus apparently by an oversight they limit the present consumption in Germany to 80 grams per man per day, according to the usual way of estimating; i.e. so as to be comparable with Voit's and Chittenden's figures (Voit considered that 105 of his 118 was fully digested).

[1] *Germany's Food; Can it Last?* . . . The case as presented by German Experts. Translated by S. Russell Wells.

It is found then that recent scientific opinion puts the hygienic protein minimum or optimum at something between 90 and 100 grams instead of any higher figure. As we have already said, it is usual to allow some increase to this average amount for athletes or persons undergoing any great exertion.

We do not recommend to our readers any fixed figure, but will give a choice of standards when giving the tables, so that any one about to criticise a diet can first fix his or her own standard. We shall give also the standard reached in certain typical diets. As will perhaps be obvious beforehand, middle- and upper-class English and American folk tend to consume daily more protein than even the highest figure stated as necessary, and people below the poverty line markedly less. Food rich in protein is more attractive to most people, and, as a rule, more expensive.

Fats and carbohydrates. The last question to be asked is, what is the proper quantity of fats and of carbohydrates in a diet? There is no need to give fixed quantities, because these two forms of food are mutually replaceable, always remembering that a given weight of fat produces a little more than twice as much energy as the same weight of carbohydrate. The three forms of food give energy; protein is also available for tissue building. When enough protein has been supplied for the latter purpose either carbohydrates or fats will supply the rest of the Calories of energy.

Voit's original statistic for the man doing medium work was 56 grams fat and 500 grams carbohydrates with the 118 grams protein. These figures have been very generally quoted in standard diets, though often with 50 grams fat instead of 56. The total Calories

come to about 3,000, a little more if 56 grams is taken. In ounces the figures would be $1\frac{4}{5}$ or 2 oz. fat, 18 oz. carbohydrates. It must not be forgotten that carbohydrate food is cheaper than fat; it forms the largest nutritive part of the cereals which are the staple foods of most parts of the world. Economical diets, such as those of the poor working class type, of prisons and of hospitals, often do not contain more than 50 to 70 grams ($1\frac{4}{5}$ to $2\frac{1}{2}$ oz.) fat, unless in a very cold climate or season, where need is felt for the food that gives the best heat value. But most well-to-do people consume more fat than this in a day; it is quite possible to find 4 oz. consumed on the average, while the carbohydrates taken at the same time often amount to 14 oz. Individuals of course vary very much in their power of digesting fats, and the fats with lower melting points (such as olive oil) are more easily digested than those with high melting points such as mutton dripping. But speaking generally 100 grams, less than 4 oz., is as much as any one can assimilate daily, and for most purposes unnecessarily much. On the other hand, carbohydrates, though well digested, throw a good deal of work on the digestive system, and the amount ought not to exceed 18 oz. When a great deal of active work is being undertaken, it is usual to increase the amount of fat if possible so as to make up the total Calories to 3,500, 4,000 or even higher.

In modifying the figures 56 grams and 500 grams given by Voit, so as to use more fat and less carbohydrates, it is perhaps sufficiently accurate to take 2 grams away from the carbohydrate total for every 1 gram added to the fat total, but $2\frac{1}{4}$ grams is better. If the daily amount of fat is about 3 oz., a little more than 14 oz.

of carbohydrates will be sufficient. But it has been stated that well-to-do families in America consume 4–5 oz. of fat per head daily. A man upon whom Voit was experimenting was put on a "medium mixed diet" which consisted of $3\frac{1}{2}$ oz. protein, $3\frac{1}{2}$ oz. fat and $12\frac{1}{4}$ oz. carbohydrates, which made up just over 3,000 Calories.

In discussing diets it is now very usual to calculate and comment upon only (1) the protein present, and (2) the total fuel value, and not to distinguish whether fats or carbohydrates are used, unless the diet is very abnormal in that respect. As a matter of economy, without regard to digestion, most normal diets could have their fat partly replaced by carbohydrates. Lusk says—"Carbohydrates are the most economical of the food-stuffs both physiologically and financially. They are the greatest sparers of protein. Ingestion of fat has for its object the relieving of the intestine from excessive carbohydrate digestion and absorption. Ingestion of fat in too large quantities leads to digestive disturbances."[1]

Nutritive ratio. When diets are summarized as so many total Calories—so many of these Calories being supplied by protein, the ratio of the latter number to the former is an important figure. It may be stated as a percentage, or as 1–6, 1–8, which is the same as saying the protein is $\frac{1}{6}$ or $\frac{1}{8}$ of the whole. It is a simple matter to ascertain the nutritive ratio (instances will be given in the Tables). The difficulty is the one which has beset us continually in discussing the proper amount of protein—what is the *right* nutritive ratio ?

Voit's figures give 15 per cent., or 1–$6\frac{2}{3}$. Atwater's,

[1] *Science of Nutrition*, p. 189.

with increased protein and increased Calories, give about the same. Hutchison (see *Food and Dietetics*), from figures which are an average from various authorities, thinks 1–5⅓ not too high. Chittenden, with only 50 grams protein to 2,500 Calories has a ratio of 8 per cent. or 1 to 12½. Hindhede, with decreased protein and comparatively high total Calories lowers it without limit. The German experts conclude that the ratio for the German nation ought not to fall below 11 per cent., or 1–9. The physiologists who now are in favour of 90–100 grams protein to 3,000 Calories will fix the ratio at 1–8. There is certainly variety to choose from. The extreme case is that of the advocates of low protein diet who wish to increase the daily amount of Calories to about 4,000, while they greatly diminish the protein, with the consequence that the ratio may readily fall as low as 1–40 or less!

If the right ratio should ever be determined it would give some standard of judgment whether a particular food is made up of constituents in about the right quantity, so that it could, alone, form a "perfect food." Not that a single form of food would prove generally desirable to people, except in the case of infants' milk. This indeed forms an interesting example. An infant of six months old, fed on mother's milk, takes as much protein as would be equivalent to 140 grams daily for the average man, yet the nutritive ratio is less than 1–10.[1]

Nutritive ratio in bread. Bread is worth considering in this aspect. It is certainly not a "perfect food," as it contains only a negligible quantity of fat, and would not suffice all purposes if eaten alone. But is it rich enough

[1] Hutchison. *Applied Physiology*, p. 4.

in protein? Opinions contradict one another in an extraordinary way. It must be premised that (1) two specimens of apparently similar bread may differ notably in protein content. (2) Two specimens of bread made from different flours will differ still more. (3) Not all the protein in bread is digested. However, the nutritive ratio is usually 1–8 or 1–9 for digested protein, 1–7¼ for crude protein. On the Voit and Atwater standard, then, it does not contain enough protein. Investigators like Rowntree and Paton have usually assumed that bread is too poor in protein to sustain life properly. But it is clear that opinion is changing if the following passage from a recent War Pamphlet[1] is quoted. "The amount of protein received (in bread) will very nearly reach what is a desirable ratio, and from this standpoint bread is a satisfactory basal food stuff." The authors go on to comment on its deficiency in fat.

At any rate, when butter or jam is taken with bread the total Calories receive an addition while the protein is unaltered, so that bread and butter and bread and jam are likely to be a less "satisfactory basal food stuffs" than bread. But there are disciples of the low-protein allowance and small nutritive ratio who find bread itself too rich in protein to be satisfactory!

[1] *Food Economy in War Time.* T. B. Wood and F. G. Hopkins.

The note on Chapter IV should be read in connection with this chapter.

CHAPTER IV

THE NUTRITIVE REQUIREMENTS OF WOMEN AND CHILDREN

So far the discussion of nutritive requirements has been confined to those of the individual called the average man; the only modifications suggested were according to variation in the man's weight, and in the amount of muscular work he does. But the most common problem for students of diet to solve is what food to supply for a household or family of different sexes and ages. The question for us now, therefore, is, what proportion of the food suitable for an average man will be needed by (1) the average woman, (2) children of various ages?

Rowntree, in his *Poverty*, and Paton and Dunlop in their Scottish Diet Studies, work from a table supplied by Atwater and Wood, in their *Dietary Studies* in New York City, 1896. The table is as follows:—

Atwater and Wood's table.

A woman	takes	·8	of the food of a man at moderate muscular labour.
A boy 14–16	„	·8	
A girl 14–16	„	·7	
A child 10–13	„	·6	
„ 6–9	„	·5	
„ 2–5	„	·4	
„ under 2	„	·3	

This is a very useful general table; but the American

authors observed at the time that it would be subject to revision when more experimental evidence was forthcoming. Although this table is now twenty years old the experiments on the subject do not seem to have been numerous since then, or to have accumulated much evidence. It is naturally easier for physiologists to make experiments on diet with men connected with their laboratories than on women and children; and it has been remarked that not enough is known about women's diet; especially about the exceptional diet needed by pregnant or nursing women, although attention has been more drawn to these exceptions than to ordinary women's methods of feeding. The German experts quoted in the last chapter have brought together all the material available to them, in a Table comparing the various pronouncements on the subject. Before giving this it will be well to vie w the problem generally.

The average man is supposed to have protein according to his weight, and not according to his work, although it may be advisable to increase his allowance if he undergoes strenuous and continual muscular st rain.

The whole number of Calories he needs is onlyroughly proportional to his weight, and must include an additional allowance for medium and for arduous muscula work. This additional allowance can be chiefly in the form of fats and carbohydrates.

Women workers. Common observation tells us that a woman naturally takes less food than a man as a rule; and this may be for two reasons—(1) her smaller weight, (2) her decreased muscular activity. As regards protein, the first of the tw considerations will be all important, and a certain proportion of the man's allowance can be settled as applying to any woman of

average weight. But as regards total Calories there must be some range for different women. The charwoman and the Cradley Heath chainmaker certainly need more than the school teacher; the modern athletic young woman also needs—and takes—more food than the "domesticated" girl who does "light home duties." The German publication quotes valuable figures for similar cases, though it does not say whence they are obtained.

Needlewomen	2,000 Calories
Machinists and book-binders . .	2,100 ,, to 2,300 ,,
Domestic Servants	2,500 ,, to 3,200 ,,
Washerwomen	2,900 ,, to 3,700 ,,

These direct numbers may often be of more use to us than the decimal fractions of men's food. Rowntree would give the average woman ·8 of 3,500 Calories, which is 2,800. The number 3,500 is his estimate, considered now rather large for the average labouring man, but 2,800 is certainly not too much for an average working-man's wife, whose work is probably heavier than a domestic servant's. Chittenden,[1] on the other hand, quotes from the report of Bedford Reformatory, in New York State, that the women there employed on hard manual labour received in food the equivalent of 81·9 gr. protein and 2,629 Calories, which is rather low in comparison with German estimates. The protein is just under 70 per cent. of the usual allowance (of 120 grams) for a man.

[1] *British Medical Journal*, June, 1911.

In most households studied, it would probably be safe to take the wife's requirements as ·8 of those of the husband. The wife of a professional man would, like himself, be doing quite light muscular work; and ·8 of the lower figure of his needs in Calories would be nearer her requirements than ·8 of Atwater's 3,500 Calories. But it must not be forgotten that some authorities (see the German Tables) allow a larger proportion—·85 or ·9; considering that the average woman approximates more nearly to the average man than is expressed by four-fifths of his weight and exertions.

It is advisable to lessen the allowance for people over sixty of both sexes, as in advanced life the exertions, and the general wear and tear are much less.

Children. It has been already suggested that in estimating children's needs it is not possible to consider them as even approximately according to weight. Their greater surface in proportion to weight causes them to need more Calories; and also more protein has to be allowed for their growth. It is stated that an infant of 10 lbs. weight has a skin surface of 3 sq. ft.; whereas a man weighing 200 lbs., instead of the surface of 60 sq. ft. which would be in proportion, has only 21 sq. ft.

It will be noticed that the Table already quoted assumes that a boy over sixteen years of age will need as much food as a man, and a girl as much as a woman; also that below thirteen years of age no difference need be made between the sexes. Some authorities, however, besides making more complete difference between the sexes, give a smaller quantity for a boy's requirements than a man's even to nineteen years and later! Common experience certainly indicates that a boy from six-

teen to nineteen eats as much, or more, than a full grown man; and Starling[1] asserts that a boy from nine to thirteen eats as much as a man, while from fourteen to nineteen he eats more. This physiologist considers that a girl reaches her maximum in requirements at about eleven years of age, and they then remain stationary for many years.

In the German collection of statistics which follows, the American figures quoted do not separate boys and girls at all, whereas the Danish ones next to them consider that girls need less than boys from birth onwards!

The Atwater Table already given treats a child's requirements as a certain fraction of those of the man doing "moderate muscular work," which they compute as 3,500 Calories. There can be no need with children, as there is with women, to differentiate needs according to class and occupation. We may assume that the same number of Calories will be needed for children of the same age in any family: and if we agree that the allowance should be ample it will not be advisable to calculate the Calories for the children as a fraction of the lower requirements of the professional father.

We will now give the Table of collected statistics from the German publication. We do not give this in the general tables of Chap. V, because it seems better to give a condensed and generalized form there. In this Table the average man's requirements are called 100, so that ·8, ·6 etc., become 80, 60 and so on.

[1] *Physiology*, p. 735.

Table from *Germany's Food: Can it Last?*

SCALE OF REQUIREMENT UNITS ACCORDING TO SEX AND AGE
1 grown man = 100

Age	Units according to—							Mean to nearest whole number
	Engel m. and f.	Rubner m. and f.	Atwater m. and f.	Zuntz m. and f.	American Household m. and f.	Danish Statistics m.	Danish Statistics f.	
under 1 year	28·6	—	30	20	15	22	17·6	22
1	31·4	21·8	30	30	15	22	17·6	24
2	34·3	29·7	40	40	15	30	24	30
3	37·1	35·4	40	40	15	36	28·8	33
4	40	38·8	40	40	40	39	31·2	38
5	42·9	42·3	40	50	40	43	34·4	42
6	45·7	43·7	50	50	40	44	35·2	44
7	48·6	45·0	50	50	75	45	36	50
8	51·4	46·4	50	50	75	47	37·6	51
9	54·3	47·8	50	50	75	48	38·4	52
10	57·1	49·2	60	75	75	50	40	58
11	60	54·4	60	75	90	55	44	63
12	62·9	59·6	60	75	90	60	48	65
13	65·7	65	60	75	90	66	52·8	68
14	68·6	70·6	80 70	75	90	71	56·8	76 72
15	71·4	73·1	80 70	100 80	100 90	74	59·2	83 74
16	74·3	75·7	80 70	100 80	100 90	76	60·8	84 75
17	77·1	78·4	80 70	100 80	100 90	79	63·2	86 77
18	80	81·6	100 80	100 80	100 90	82	65·6	91 80
19	82·9	100 —	100 80	100 80	100 90	100	80	97 83
20	85·7	100 —	100 80	100 80	100 90	100	80	98 83
21	88·6 85·7	100 —	100 80	100 80	100 90	100	80	98 83
22	91·4 85·7	100 —	100 80	100 80	100 90	100	80	98 83
23	94·3 85·7	100 —	100 80	100 80	100 90	100	80	99 83
24	97·1 85·7	100 —	100 80	100 80	100 90	100	80	99 83
25–29	100 85·7	100 —	100 80	100 80	100 90	100	80	100 83
60 and over	100 85·7	100 —	100 80	90 80	100 90	100	80	100 83

There are several interesting points in these figures. Note first the varying ages at which a boy or young man is considered to need the full quantity of food allowed for an adult. What about the allowance for declining years? Zuntz, whose figures seem to be the most recent, is the only authority who decreases the requirement after sixty years of age, and he does not think it necessary to do so for women.

It will hardly be necessary for us to use the decimal figures given in some lists. The first German writer who gives them (Engel) would seem to have started with seven year periods as a basis, and to have designed round numbers to those. Thus.

	Allowance.
Age 4	40
„ 11	60
„ 18	80
„ 25	100

One feels doubtful whether youth of both sexes from eighteen to twenty-five should remain on 80 per cent. of full allowance.

The American household does not give babies under four very ample diet; and Danish children, both male and female, seem to be brought up with Spartan moderation. The closest agreement for children in the varying figures in the columns is at the age of four. Omitting Danish female babies the figures are 38·8, 39 or 40.

The German experts finally took the mean of all these figures, but only at the end of some elaborate further calculations. A mean has been calculated, therefore, and given in the last column (in round numbers without decimals). If this list of mean results

is compared with Atwater and Wood's original table, there is no great change to note; there would be still less if the extraordinarily low figures for Danish girl children were omitted.

As the figures stand they compare as follows—

Atwater and Wood.		Generalised mean from German quotations.
A woman	·8	·83
A boy over 16	1	·92
Boy 14–16	·8	·81
Girl 14–16	·7	·74
Child 10–13	·6	·64
Child 6–9	·5	·49
Child 2–5	·4	·36
Child under 2	·3	·23

It is suggested that the student should use her discretion in selecting what numbers to use for a particular family; but that the Atwater and Wood table still seems fairly reliable.

Addendum.—Prof. Bowley, in *Livelihood and Poverty*, 1915, uses the following table :—

Age.	M.	F.
Over 18	100	80
16–18	85	80
14–16	85	70
5–14	50	50
0–5	33	33
People in receipt of Old Age Pensions	60	60

CHAPTER V

TABLES

N.B.—Tables I and II should be reviewed in the light of the newer work summarized in the note on Ch. IV.

TABLE I

General Statement of the Dietary Requirements of a Single Individual per Day

A man weighing 70 kilograms and living an ordinary life, needs in Protein—

Grams.	Oz.	According to
120	$4\frac{1}{4}$	Voit and Atwater (mean)
95–100	$3\frac{1}{2}$	Recent Physiologists
60–70	$2\frac{1}{8}$–$2\frac{1}{2}$	Chittenden.

For great physical strain the number of grams may be increased to 150; and 190 grams is demanded by some authorities for men like soldiers on active service.

This is crude protein, i.e. the amount actually taken in the food. The amount digested varies with the kind of food: about 10 per cent. may be deducted to give the amount of digestible protein.

Advocates of low protein diet allow 1 gram protein per kilogram weight; Chittenden would decrease this to ·85 crude protein, ·75 digestible protein

In Calories the same man requires—

2,500 for a sedentary life.

3,000 for light muscular work.
3,500 for medium muscular work
4,000 and upwards for very heavy toil.

It is computed that all but about 8 per cent. of this is utilised.

Compare these numbers with the dietaries which have been used as standards :—

	P.	C.
Voit, original, moderate muscular work .	118 gr. $4\frac{1}{4}$ oz.	3,055
Atwater, moderate muscular work . Used by Rowntree and by Paton	125 gr. $4\frac{1}{2}$ oz.	3,500
Atwater, for man at light work . .	100 gr. $3\frac{1}{2}$ oz.	2,700

	Fat. grams.	Carbohy drates grams.
Fats and Carbohydrates.		
Voit, original standard . .	**56** **2 oz.**	**500** **18 oz.**
This is often quoted as . .	**50** **$1\frac{3}{4}$ oz.**	**500** **18 oz.**

Atwater and later workers do not consider it necessary to specify how the Calories otherwise than those obtained from protein are to be divided. But the proportion above—1–10—is lower than in most diets, except (1) in hot countries, (2) where expense is the chief consideration. A proportion of 1–5 has been suggested as more suitable.

	Fat.	Carbohydrates
This would be about . . .	**80** **3 oz.**	**400** **14 oz.**

The following computations of the materials contained in actual dietaries are useful for reference, though not necessarily for imitation :—

	Protein Grams	Fat Grams	Carbo-hydrates Grams	Calories	Authority
INDIVIDUALS.					
Average inhabitant of various cities—					
London	98	60	416	2665	Rubner from statistics of municipal consumption
Paris	98	64	465	2903	
Munich . . .	96	65	492	3014	
Konigsberg . .	84	31	414	2394	
U.S.A. Farmers' Families, from food purchased	101	128	476	3560	Atwater.
U.S.A. Mechanics' Families, ditto .	113	153	420	3605	”
U.S.A. Professional Man's families, ditto	110	136	442	3530	”
Professional Man . .	104	125	423	3325	”
Boarding house, N.Y..	114	150	522	4002	”
Students' Clubs, U.S.A.	105	147	465	3705	”
Labourers in Edinburgh	107	88	479	3228	Paton & Dunlop
Poor Families in N.Y. & Philadelphia (mean)	108	—	—	3150	Atwater
English Labourer . .	140	34	435	2733	J. König, 1904
French Labourer . .	138	80	502	3419	”
Berlin Labourer . .	98	69	490	3075	”
French-Canadian Labourer . . .	108	—	—	3585	Atwater
German Factory Operative . .	143	—	—	4170	Atwater
Swedish Factory Operative . . .	161	—	—	4080	”
Russian Factory Operative . .	113	—	—	3061	
American Factory Operative	127	—	—	4415	”
French-Canadian Factory Operative .	123	—	—	4620	”

	Protein Grams	Fat Grams	Carbo-hydrates Grams	Calories	Authority
U.S. Army [1]	120	161	454	3851	Atwater
U.S. Navy	143	184	520	4998	,,
Requirements of Seamen's Federation.	170	—	—	4526	Paton-Dunlop
INSTITUTIONS.					
Workhouses—					
English	138	—	—	3381	Paton-Dunlop
,, (York)	136	—	—	3702	Rowntree
Scottish	113	—	—	2381	Paton-Dunlop
Lunatic Asylums	136	—	—	3435	,,
Prisons—					
Scottish and English (mean)—					
Ordinary prisoners	134	—	—	3075	,,
Convicts with hard labour	175	—	—	3938	,,
Hospital—English	107	69	533	3266	Rubner
WOMEN.					
U.S.A. Women Students' Clubs [2]	101	139	414	3405	Atwater
Sewing girl, London, getting 3*s.* 9*d.* per week	53	33	316	1820	,,
Factory girl, Leipzig	52	53	301	1940	,,
OLD PEOPLE.					
Men	92	45	332	2149	Forster
Women	80	49	266	1875	,,

[1] The most recent report on English soldiers' diet was issued in 1889. It was then compared with that of other European countries, and found to be the most plentiful in meat. Switzerland and France came next, then Austria. Germany is low on the list, so is Russia. England has a smaller bread allowance than Germany. Russia's bread allowance is very large, $2\frac{1}{4}$ lb. Dr. Dunlop has calculated the daily ration at Ladysmith at the end of the siege to have been equivalent to 73·4 gr. protein, 1,527 Calories.

[2] Compare with similar men's clubs above. The difference is not great.

For Climate Comparisons.

	Average Body Weight	Protein	Calories	Authority
Eskimo	65	282	2604	Lusk
European . . .	70	118	3055	,,
Bengali . . .	50	282	2390	,,

Requirements of the Body in Water.

About two-thirds of the weight of the body consists of water. From 4 to 4½ pints are excreted by an average man daily. This quantity should therefore be taken in the diet. Ordinary solid food contains from 1 to 1½ pints.

Therefore, a quantity between 2 and 3 pints should be drunk as liquid.

A greater use of pure cold water than is customary is recommended by more than one authority.

Requirements of the Body in Mineral Salts.[1]

A body weighing 154 lb. contains about 8 lb. 12 oz. of mineral matter. In this there is estimated to be

	lb.	oz.
Calcium phosphate, ,, carbonate }	1	·08
Magnesium phosphate . .		7·0
Sodium sulphate, phosphate and carbonate		2·2
Potassium sulphate, phosphate and carbonate		1·7
Silica		·1

and iron, iodine and fluorine in smaller quantity.

[1] Tibbles, Foods, their Origin, etc.

Food may be arranged in the following order according to the contribution of minerals generally :—

1. Pulses and cereals.
2. Vegetables.
3. Meat.
4. Fruit, including nuts.

Iron. The following list was given by Bunge according to the contribution of iron :—

Spinach (and other green vegetables).
Yolk of egg.
Beef.
Apples.
Lentils, beans, peas.
Strawberries.
White of Egg.
Wheat.
Potato.
Milk.

Cheese and butter are also deficient in iron ; oatmeal rice and maize contain more than wheat.

Calcium. Milk, eggs, cereals and vegetables supply this ; meat, fish, potatoes, fruit are deficient.

Phosphorus.

Animal foods in order.	Vegetable foods in order
Cheese (certain sorts)	Haricot beans.
Mutton.	Barley.
Cheese (other sorts).	Chestnuts.
Eggs.	Potato.
Beef.	Cabbage.
Milk.	Turnips.
Pork.	Carrot.

Salt. About 15 grams ($\frac{1}{2}$ oz.) is excreted daily. This should therefore be a sufficient daily amount.

TABLE II. (*See also* Chapter IV)

Dietary Requirements of Women, Children and Old People.

Atwater's Table, Unaltered.

Average man at moderate muscular labour	1
A woman	·8
Boy 14–16	·8
Girl 14–16	·7
Child 10–13	·6
„ 6–9	·5
„ 2–5	·4
„ under 2	·3

Modifications :—

(1) A woman may be taken at ·85 or ·9 of the average man, or her needs may be estimated directly according to her calling—

	Calories.	Protein.
Sedentary work	2,000	70–80
Machine-minders	2,200	80
Domestic work	2,500–3,200	100
Hard physical labour	2,900–3,700	120

(2) To both boys and girls from 10 to 16 may be assigned a larger proportion ; say $\frac{1}{10}$ larger—one figure higher in each case.

(3) For men over 60 ·9 is suggested. For old age ·8 or less, see Bowley, p. 46.

TABLE III

General Table for Food Values of Food as Purchased.

To be used in calculating the amount of protein and other food material in a weekly or daily diet, from the household accounts.

Any article of food not mentioned here may be found in later tables. The analyses are chiefly American, as there has been so much useful material supplied by the U.S.A. Department of Agriculture, in a convenient form. But wherever possible British analyses of recent date have been substituted, because there are often noticeable differences in the character of the food supplied in the different countries. Beef is differently cut; and prepared foods may have different compositions.

Food	Protein per cent.	Fat per cent.	Carbo-hydrates per cent.	Calories per lb.
Average of beef, veal and mutton	14·5	16·1	—	913
Beef, average	15·2	15·5	—	935
„ Best cuts	16·4	16·9	—	1020
„ Shank (hock or shin)	11·4	4·5	—	405
Mutton, average of leg, shoulder and neck	13·8	17·1	—	977
Veal	15·6	6·3	—	535
Pork	12	29·8	—	1477
Ham	14·5	33·2	—	1670
Bacon	9·5	59·4	—	2685
Sausages, Pork [1]	12·3	21	1·1	1132
„ German	16·6	17·9	·5	1070

[1] There is very large variation in the composition of these in the amount of fat, and also in the amount of bread or other carbohydrate material introduced.

Food	Protein per cent.	Fat per cent.	Carbo-hydrates per cent.	Calories per lb.
Tongue, Tinned Ox-[1]	19·5	23·2	—	1340
Corned Beef, Tinned[1]	26·3	28	—	1610
Mutton, Tinned[1] . .	27·6	14·4	—	1078
Fowl (average of U.S.A. figures)	16·3	10·2	—	730
Duck . . .	15·4	16	—	1085
Rabbit	21·5	2·5	—	504
Potted Meat[2] . .	23·6	27·7	0–15	—
Fish, general average as sold .	10·9	2·4	—	295
„ „ „ without refuse	18·4	4·3	—	526
„ rich in fat, as Herring .	19·5	7·1	—	660
„ ditto Salmon .	22	12·8	—	950
„ Medium fat, as Halibut Mackerel, Mullet .	18·9	5·6	—	588
„ not fat, as Cod, Haddock .	16·8	·35	—	330
Molluscs (Lobster, Crab, Shrimp)	9·5	·5	—	220
Herring, Salt (average)	18·9	15·8	—	837
„ Smoked (average)	19·4	5·6	—	592
Haddock, Smoked	18·7	—	—	347
Salmon, Tinned . . .	19·5	7·5	—	658
Sardines, Tinned. .	4·3	12·7	—	614
Eggs (weight 2 oz. in shell) .	11·9	9·3	—	613
Milk[2] (20 oz. to pint) .	3·3	4	5	322
„ Skim . . .	3·4	0·3	5·1	170
„ Buttermilk . . .	3	0·5	4·8	160
„ Condensed, unsweetened	9·6	9·3	11·2	780
„ Condensed, sweetened	9	13·5	51·5	1693
Cream,[2] thin	2·5	18·5	4·5	908
„ thick	1·4	67·6	2·2	2912
Butter	1·0	83	—	3510
Margarine	1·2	83	—	3520
Lard	2·2	94	—	4000
Suet	4·7	81·8	—	3540
Cheese[2]	25·2	33·7	2·4	1950

[1] Tinned meat is more concentrated food than fresh. As an average 1 lb. is equal to about 1½ lbs. fresh meat.

[2] Subject to considerable variation.

Food	Protein per cent.	Fat per cent.	Carbo-hydrates per cent.	Calories per lb.
Flour (average)	11·4	1	74·8	1650
Bread (average	9·2	1·3	53·1	1215
Cakes [1] (average)	6·3	9	63·3	1670
Biscuit [1] (average)	8.3	9	75	1935
Barley (Pearl)	7·4	1·2	76·7	1615
Cornflour	—	—	90	1670
Macaroni	10·9	0·6	75·9	1636
Rice	7·4	·4	79·2	1620
Sago	0·2	0·2	86·7	1620
Semolina	12	·7	76	1662
Tapioca	0·3	·2	88	1685
Sugar, White	—	—	100	1790 [2]
„ Brown	—	—	95	1700 [2]
Syrup, Golden	2·4	—	69·3	1330
Jam	·6	·1	61	1145
Dried Fruit (currants and raisins, average)	1·8	3·8	69·3	1480
Dry Pulses—				
Beans	23·1	2·3	53·6	1520
Lentils	24·8	1·8	54·8	1552
Peas	22·6	1·7	53·2	1464
Nuts in shells [1]	16	60	12	3040
Potatoes	1·8	0·1	14·7	310
Onions, Carrots, Turnips, etc. [3]	1·3	·3	8	184
Green Vegetables [3]	1·4	·2	4·8	145
„ Salads	1·0	—	3·0	65
Tomatoes	0·9	·4	3·9	105
Bananas	1·3	·6	21	440
Fruit, (average)	0·4	·5	8	180
Cocoa [4]	21·6	28·9	37·7	2320
Chocolate (solid)	12·9	48·7	30·3	2855
Beer	·6	—	1·3	35

[1] Considerable variation.

[2] Lusk's figures.

[3] Much of the food value may be wasted if cooked in a large quantity of water. See Tables xxv–xxvii.

[4] The nutritive contents of tea and coffee are negligible.

Fuller Tables of Analysis; to be used for the consideration of any food in detail, or any dish in which it occurs; particularly with reference to its price.

TABLE IV.

Meat.

	Refuse	Water	Protein	Fat	Ash	Calories per lb.
Beef.[1]						
Brisket	23·3	41·6	12	22·3	0·6	1165
Flank	5·5	56·1	18·6	19·9	0·8	1185
Loin (whole)	13·3	52·9	16·4	16·9	0·9	1020
Steak (porter-house)	12·7	52·4	19·1	17·9	0·8	1110
Ribs	20·1	45·3	14·4	20	0·7	1110
Round (best)	8·5	62·5	19·2	9·2	1	745
„ 2nd cut	19·5	56·2	16·4	6·9	0·9	595
Rump	19	46·9	15·2	18·6	0·8	1065
Shank (fore) or shin	38·3	43·2	13·2	5·2	0·6	465
Shank (hind) or hock	55·4	31	9·7	3·9	0·4	345
Beef Organs.						
Ox Heart	5·9	53·2	14·8	24·7	0·9	1320
„ Kidney	19·9	63·1	13·7	1·9	1	335
„ Liver	7·3	65·6	20·1	3·1[2]	1·3	555
„ Tongue	26·5	51·8	14·1	6·7	0·8	545
Tripe	—	?	14·1	3·1	—	392
Salt Beef.						
Brisket	21·4	40	14·4	19·4	4·5	1085
Rump	6·0	54·5	14·3	22	3·1	1195
Veal.						
Breast	24·5	51·3	15·3	8·6	0·8	645
Cutlets	3·4	68·3	20·1	7·5	1	690
Leg	11·7	63·4	18·3	5·8	1	585

[1] These are almost all Atwater's analyses; but the ox carcase is differently cut, and the parts somewhat differently named in America. The cuts quoted are as nearly as possible those usual in England. All the analyses are for the meat *as purchased*, beef and all succeeding items.

[2] Also 2·5 per cent. of the carbohydrate glycogen, a substance resembling starch which is constantly formed in the liver from sugar.

	Refuse	Water	Protein	Fat	Ash	Calories per lb.
Loin	18·9	56·3	16·1	8·2	0·9	645
Rump	30·2	43·7	13·8	11·3	0·8	735
Shoulder (lean)	18·3	59·9	16·9	3·9	1	480
Liver	—	73	19	5·3	1·3	575
LAMB.						
Breast	19·1	45·5	15·4	19·1	0·8	1090
Leg	13·8	50·3	16·0	19·7	0·9	1130
Loin	14·8	45·3	16·0	24·1	0·8	1315
Neck	17·7	46·7	14·6	20·4	0·8	1135
Shoulder	20·3	41·3	14·4	23·6	0·8	1265
Forequarter	18·8	44·7	14·9	21	0·8	1165
Hindquarter	15·7	51·3	16·5	16·1	0·9	985
MUTTON.						
Leg	17·7	51·9	15·4	14·5	0·8	900
Loin	14·8	40·4	13·1	31·5	0·6	1575
Neck	26·4	41·5	12·2	19·6	0·7	1055
Shoulder	22·1	46·8	13·7	17·1	0·7	975
Forequarter	21·2	41·6	12·3	24·5	0·7	1265
Hindquarter	17·2	45·4	13·8	23·2	0·7	1235
Heart	—	69·5	16·9	12·6	0·9	845
Kidneys	—	78·7	16·5	3·2	1·3	440
Liver	—	61·2	23·1	9[1]	1·7	905
PORK.						
Head	68·4	13·8	4·1	13·8	0·2	660
Loin chops	19·3	40·8	13·2	26·0	0·8	1340
Middle loin	19·7	38·6	12·7	28·9	0·7	1455
Shoulder	12·4	44·9	12·0	29·8	0·7	1480
Leg	10·3	45·1	14·3	29·7	0·8	1520
Feet	74·1	14·3	4·1	6·9	0·2	365
Liver	—	71·4	21·3	4·5[2]	1·4	615
Heart	—	75·6	17·1	6·3	1·0	585
	Water	Protein	Fat	Carbo-hydrates	Ash	Calories
Pork Sausages	55	12·3	21	1·0	2·5	1130
„ Cambridge	51·5	9·5	29·7	2·2	3·5	1450
Sausage, German	46·5	16·6	17·9	15·0	4·5	1340
Polony	45·6	17·3	32·6	0·5	2·8	1695

[1] Carbohydrate (glycogen) 5 per cent.
[2] Carbohydrate (glycogen) 1·4 per cent.

Cooked Meat as Purchased in U.S.A.

	Refuse	Water	Protein	Fat	Ash	Calories per lb.
Roast Beef, slices.	—	48·2	22·3	28·6	1·3	1620
Roast Lamb (leg).	—	67·1	19·7	12·7	0·8	900
Lamb Chops . .	13·5	40·1	18·4	26·7	1·2	1470
Roast Mutton, Leg (slices) . .	—	50·9	25	22·6	1·2	1420

Comparison of Meat Raw and Cooked

(König, quoted by Hutchison).

	Water per cent.	Protein per cent.	Fat per cent.	Extractives per cent.	Min. Matter per cent.
Beef, Raw. .	70·9	22·5[1]	4·5	0·9	1·2
„ Boiled .	56·8	34·1	7·5	0·4	1·1
„ Roasted.	55·4	34·2	8·2	·7	1·4
Veal Cutlets—					
Raw . .	71·6	20·2	6·4	0·7	1·1
Roasted . .	57·6	29	11·9	·03	1·4

It is computed that generally 4 oz. cooked meat is produced from 5 oz. raw meat, the loss being a great extent water.

[1] These are very high values. The nature of the beef is not described but it seems to have been lean meat from a first-class cut.

TABLE V.

POULTRY (chiefly from *Farmers' Bulletin* No. 34).

	Refuse	Water	Protein	Fat	Ash	Calories per lb.
Chickens, Young, U.S.A.	18·8	55·5	17·8	7·2	0·9	635
„ Dark Meat	—	70·1	20·8	8·2	1·2	730
„ Light Meat	—	70·3	21·9	7·4	1·1	720
Capon, U.S.A. .	17·5	46·8	17·7	17·5	1·0	1065
„ Roast, English (flesh) .	—	59·9	27	11·5	1·3	985
Other Fowls, U.S.A.	25·2	47·3	14·4	12·6	0·7	800
Turkey, U.S.A.	14·3	49·2	19	16·2	1·0	1035
Dark meat, cooked	—	53·7	39·2	4·3	2·2	910
Light meat, cooked	—	58·5	34·6	4·9	1·8	850
Duck, U.S.A. . .	15·9	51·4	15·4	16·0	1·1	960
Goose, U.S.A. .	11·1	48	14·8	25·5	1·0	1350
Pigeon, U.S.A. .	13·6	55·2	19·7	9·5	1·3	765
Pheasant, U.S.A.	12	61·5	21·5	4·2	1·0	580

SOUPS, JELLIES AND MEAT EXTRACTS.

In making soup from meat it is customary to eliminate the fat as much as possible, but the assumption is that much of the protein will pass into the liquid. This is not the case. A large proportion remains in the meat, some passes into the water and coagulates there; it will render the soup nutritious if it is not removed in the process of "clearing" to obtain a liquid without flocculent particles. Certain nitrogenous substances known as EXTRACTIVES pass readily into the water, and impart the pleasant meaty flavour. They form good stimulants, especially to digestion, but have no food value. With

most meat, and especially with bones, some quantity of gelatin passes into the soup. Gelatin is more nearly analogous to protein in its composition than are the extractives; it has great food value, but no tissue-building value.

Ordinary stock may be said to be about 93 per cent. water, at most 5 per cent. nutritive matter. In an experiment quoted by Wiley 1 lb. beef, and $\frac{1}{3}$ lb. veal bones produced on concentration 1 pint of liquid with the composition,

Water per cent.	Protein per cent.	Fat per cent.	Extractives per cent.	Ash per cent.	Calories per lb.
95·2	1·2	1·5	1·8	0·3	85

A good home-made beef-tea has usually a composition of this kind :—

88·0	8·0	—	3·5	1·5 with salt	150

A similar stock to which (1) pea-flour, (2) potatoes were added, had then the following composition.

	Water	Nitrogenous Matter	Fat	Carbo-hydrates	Ash
Pea-flour soup	88·3	3·4	0·9	6·3	1·1
Potato soup	91·0	1·4	1·5	5·1	1·0

A clear soup contains only 1½ to 2½ per cent. solid matter. The following American analyses of soups are quoted by Tibbles. The presence of carbohydrates in all suggests that some vegetable material must have been added to the stock, even when not described, unless glycogen was present.

TABLE VI

Soups.

	Water per cent.	Protein per cent.	Fat per cent.	Carbo-hydrates per cent.	Ash per cent.	Calories per lb.
Soups, Home-made.						
Beef	92·9	4·4	0·4	1·1	1·2	120
Chicken. . . .	84·3	10·5	0·8	2·4	2·0	275
Meat	84·5	4·6	4·3	5·5	1·1	379
Bean . . .	84·3	3·2	3·2	9·4	1·7	295
Tinned.						
Consommé	96	2·5	—	0·4	1·1	55
Julienne . .	96	2·7	—	0·5	0·9	60
Mock Turtle . .	89·8	5·2	0·9	2·8	1·3	185
Mulligatawny . .	89·3	3·7	0·1	5·7	1·2	180
Oxtail	88·8	4·0	1·3	4·3	1·6	210
Pea	86·9	3·6	0·7	7·6	1·2	235
Tomato	90	1·8	1·1	5·6	1·5	185
Turtle	86·6	6·1	1·9	3·9	1·5	165

Soup Tablets.—The only analyses at present available are of two German preparations (see Wynter Blyth).

Condensed Pea soup . .	7·6	16·9	9·0	53·4	11·7	1342
Pea-meat Tablets . .	12·1	31·2	3·1	47·5	6·2	1591

Bones and Gelatin.—"Bones, etc." in Rowntree's table contains protein 9·7, fat 3·9; but, unless the protein came from the "etc." gelatin is the more likely nitrogenous material from bones. Hutchison says that bones may contain

Water per cent.	Gelatin per cent.	Fat per cent.	Ash per cent.
5–50	15–50	½–20	20–70

The composition of gelatin itself, and of isinglass, a fish derivative of the same nature but much more expensive, and of jelly, are given by him thus—

TABLE VIA

GELATIN AND JELLY

	Water per cent.	Nitrogenous matter per cent.	Fat per cent.	Carbohydrates per cent.	Ash per cent.	Calories per lb.
Gelatin	13·6	91·4	0·1	—	2·1	1705
Isinglass . .	19	89·3	1·6	—	2	1730
Calves' Foot Jelly	77·6	4·3	—	17·4	0·7	405

It will be seen that the gelatinous nitrogenous substance has a good fuel value; but then 2 per cent. is the usual quantity of it in a jelly; and even a 1 per cent. solution will set.

Agar-agar and *Iceland Moss*. According to Lusk these are not digested, and therefore have no food value.

TABLE VII

Meat Extracts and Juices (from Hutchison).

	Water	Protein Insoluble	Protein Soluble	Extractives	Mineral Matter
Extracts—					
Oxo	39·7	4·6	13·5	24·1	18
Lemco	17·1	14·1		9·0	5·7
Nursing Oxo	23·3	5·8	33·5	21·7	15·7
Bovril	38·1	8·4	3·8	31·8	17·9
Invalid Bovril	21·8	—	21·4	39·6	17·2
Brand's Essence	87·2	—	5·4 5·0 gelatin	1·0	1·4
Armour	24·3	—	14·5	40·6	19
Meat Juices—					
Valentine's	51·2	9·7		11·2	1·8
Armour's	74·1	8·3		9·5	7·5
Brand's	59·2	15·5		16·6	8·8
Hipi (Extract of Mutton	35·2	7·7	1·2	16·6	8·4
Vegetable extract from yeast—					
Marmite [1]	26·8	10·5		34·7	27

The quantity of each of these extracts used at a time is of course very small; between ⅛ and ¼ oz. for one person.

[1] Supplied by makers.

See also Allen, "Commercial Organic Analysis," Vol. IV. By desiccating 4 lbs. fresh, lean meat 1 lb. dry substance can be obtained, of this 80 per cent. is nutritive protein matter; 20 per cent. fat, meat-bases, salts. *By no process can there be further concentration.*

TABLE VIII

Fish.[1]

Food	Edible Portion					Refuse
	Water	Protein	Fat	Ash	Calories per lb.	
Cod . . .	82·6	16·5	·4	1·2	325	52·5 (whole)
Eel . .	71·6	18·6	9·1	1·0	730	20·2 (dressed)
Flounder .	84·2	14·2	0·6	1·3	290	57·0 (dressed)
Haddock .	81·7	17·2	0·3	1·2	335	51·0 (dressed)
Halibut .	75·4	18·6	5·2	1·0	565	17·7 (dressed)
Herring .	72·5	19·5	7·1	1·5	660	42·6 (whole)
Mackerel .	73·4	18·7	7·1	1·2	645	34·6 (whole)
Mullet . .	74·9	19·5	4·6	1·2	555	57·9 (whole)
Salmon	64·6	22	12·8	1·4	950	—
Smelt . .	79·2	17·6	1·8	1·7	405	41·9 (whole)
Trout, River	77·8	19·2	2·1	1·2	445	48·1 (whole)
,, Salmon	70·8	17·8	10·3	1·2	765	—
Turbot .	71·4	14·8	14·4	1·3	885	47·7 (whole)
Cod, dry salt	81·5	16·2	·74	1·56	305	25
Herring, salt	46·2	18·9	16·9	16·4	1065	44
,, Smoked	69·5	21·1	8·5	1·2	620	—
Mackerel, salt	44·4	19·2	22·4	13·8	1165	20
Sardines—						
Sicilian	50·2	4·3	12·7	7·5	615	—
Sardinian	40·7	3·8	23·7	9	1065	—

[1] The reader must note carefully that the percentages of protein, etc., given here are for the *edible portion* of the fish after the refuse (bone, skin, etc.), are removed. The figures are taken from Hutchison's *Food and the Principles of Dietetics*. The percentages of refuse (on the right), are from *Farmers' Bulletin* No. 85, U.S.A. Department of Agriculture.

TABLE IX

Eggs. (*Farmers' Bulletin*) *No.* 128

	Refuse	Water	Protein	Fat	Ash	Calories per lb.
Hens'[1] as purchased						
Aver. weight, 2 oz.	11·2	65·5	11·9	9·3	0·9	613
Edible portion .	—	73·7	13·4	10·5	1·0	690
White . .	—	86·2	12·3	0·2	0·6	237
Yolk .	—	49·5	15·7	33·3	1·1	1693
Boiled, edible portion . .	—	73·3	13·2	12·0	0·8	750
White-shelled eggs, as purchased .	10·7	65·6	11·8	10·8	0·6	675
Brown-shelled eggs, as purchased .	10·9	64·8	11·9	11·2	0·7	695
Ducks' eggs, as purchased . .	13·7	60·8	12·1	12·5	0·8	750
Turkeys' eggs, as purchased	13·8	63·5	12·2	9·7	0·8	635
Plover eggs, as purchased . .	9·6	67·3	9·7	10·6	0·9	625
Dried Egg Powder, European . .	—	6·4	46·7	39·5	4·4	2530

[1] A hen's egg is roughly 12 per cent. shell, 58 per cent. white, and 30 per cent. yolk.

TABLE X

Egg Powders and Custard Powders.[1]

	Starch	Albuminous Compounds	Colouring	Soda	Tartaric Acid	Phosphoric Acid	Water
Bird's Custard	86·2	0·59	0·88	—	—	—	11·8
Goodall's Custard	84·4	0·58	·9	—	—	—	13·7
Goodall's Egg Powder[2]	51·03	6·01	—	15·3	13·7	0·24	11
Borwick's Egg Powder .	26·4	3·0	—	50·7	10·3	—	9·6
Yeatman's Egg Powder . .	52·3	6	—	22·1	11·4	—	8·2
Model Egg Powder .	53·8	5	—	26·7	6·2	—	8·2

MILK

No useful table can be given for variation in cows' milk, as this variation depends on (1) the breed of cow, (2) what food it takes, (3) the season, (4) the time of day, as well as on other conditions. Milk for inspection is required to contain at least $3\frac{1}{4}$ per cent. fat, and about 12 per cent. total solids ; i.e. not more than 88 per cent. water. The content of fat may be as great as 6 or 8 per cent. Generally the amount of lactose or milk

[1] Analyses quoted by Hutchison from an article in *Food and Sanitation*, 1893.

[2] Contains in addition 2·7 per cent. of carbonates of lime and magnesia

sugar is complementary to this. The protein varies from 2½ to 3¼ per cent. In the following table the difference between human and cows' milk should be noted carefully as important in the feeding of infants.

TABLE XI

MILK OF VARIOUS KINDS (chiefly from Lusk).

Kind	Water	Total Solids	Casein	Albumin	Total Protein	Fat	Milk Sugar	Ash	Calories per lb.
Human	87·6	12·6	0·8	1·2	2·0	3·7	6·4	0·3	310
Cow .	87·3	12·8	2·9	0·5	3·4	3·7	4·9	0·7	310
Goat .	86·9	13·1	2·9	0·9	3·8	4·1	4·6	0·8	315
Sheep .	83·6	16·4	4·2	1	5·2	6·1	4·7	1	410
Reindeer	67·2	—	8·4	1·5	9·9	17·1	2·8	1·5	976
Mare .	90·6	9·9	1·3	·7	2	1·1	5·9	0·4	192
Ass . .	90·1	10·4	0·8	1·1	1·9	1·4	6·2	0·5	215

Condensed Milk.—The unsweetened should be diluted to three times its bulk (1 of milk to 2 of water) to be the same strength as ordinary milk. About the same dilution would make the sweetened milk equivalent to fresh milk in content of protein and fat, but it is generally much more diluted because of its sweetness. A dilution to 4 times its bulk gives protein 2·2, and fat 3·4, which is dilute as regards these nutrients, but still too sweet for general use.

Cheap condensed milks are skim milks, and very deficient in fat, containing only about 1·5 per cent. They are always sweetened.

The following analyses of condensed milk are taken, with slight modifications, from Chalmers Watson *Food and Feeding*.

TABLE XII

Condensed Milks.

	Water	Protein	Fat	Lactose	Cane Sugar	Calories approx.
Unsweetened.						
Ideal	62	8·3	12·4	16	—	850
First Swiss	62·2	9·9	11·3	14·4	—	
Hollandia	57	11·3	9·8	18·5	—	
Sweetened.						
Nestlé	22·8	9·7	13·7	15·0	37·2	1600
Rose	23·4	8·3	12·4	17·6	36·1	
Milkmaid	23·7	9·7	11·0	14·6	38·7	
Full Weight	23·5	12·3	11·0	13·5	37·2	
Anglo-Swiss	25·6	8·8	10·8	16	37·1	
Dried Entire Milk	5·4	28·5	29·3	31·4	—	2210
Dried Skim	9·00	40·00	2·00	36·6	—	1505

TABLE XIII

Melting Points of Butter and Other Fats.

The following is a Table from Wynter Blyth of the melting points of different fats :—

Margarine	31.3° C.
Cocoa butter	34·9
Butter	35·8
Beef dripping	43·8
Veal dripping	47·7
Mixed dripping	42·6
Lard	42–45
Beef fat	48–53
Mutton fat	50–51

The following are taken chiefly from Wynter Blyth :—

TABLE XIV

Different Kinds of Cheese.

Name	Water	Protein	Fat	Ash	Calories per lb.
American cheese (average) .	27·4	30	32·4	4·1	1918
Camembert . .	45·6	26·5	32·2	4·2	1846
Cheddar . . .	32	34·2	26·1	3·8	1731
Cheshire . .	42·1	28·1	31·5	4·5	1849
Cream . . .	57·6	19	39·3	3·4	2232
Dutch . . .	39·6	30	11·5	6·4	1040
Gorgonzola .	39·2	25·9	26·9	4·7	1600
Gloucester, double	35·5	30	25	4·6	1609
,, single	21·4	48·1	25·4	4·1	1962
Gruyere .	34	29·1	29·1	3·9	1787
Neufchâtel .	37·9	23·1	41·3	3·4	2158
Parmesan . .	32·5	17·1	17·1	6·2	1517
Roquefort	29·6	27·8	30·3	6·7	1790
Skim Milk Cheese	43·1	48	·9	6·2	1270
Stilton . . .	37·6	23·9	38·9	3·1	2080
St. Ivel	35·9	23·6	35	3·7	1808
Wensleydale .	28·3	26·8	38·3	3·7	2104
Brie . . .	51·9	18·5	24·8	5	1387

WHEAT AND OTHER CEREALS; FLOUR; BREAD

TABLE XV

CEREALS ARRANGED IN THE ORDER OF THEIR RICHNESS IN VARIOUS CONSTITUENTS (from Hutchison).

	Protein	Fat	Carbohydrates	Mineral Matter
(Most)	Oats	Oats	Rice	Barley
	Wheat	Maize	Rye	Millet
	Millet	Millet	Wheat	Buckwheat
	Buckwheat	Buckwheat	Barley	Oats
	Rye	Rye	Maize	Rye
	Barley	Wheat	Millet	Wheat
	Maize	Barley	Buckwheat	Maize
(Least)	Rice		Oats	Rice

TABLE XVI[1]

ANALYSES OF VARIOUS GRAINS.

Grain	Water	Protein	Fat	Carbohydrates		Ash	Calories per lb.
				Starch and Sugar	Fibre		
Maize . .	10·8	10	4·3	71·7	1·7	1·5	1700
Barley . .	10·9	11	2·3	69·5	3·8	2·5	1595
Oats . . .	11·0	11·8	5·0	59·7	9·5	3·0	1540
Rice . . .	12·0	8	2·0	76·0	1	1·0	1645
Rye . .	10·5	12·2	1·5	71·8	2·1	1·9	1625
Wheat . .	10·6	12·2	1·7	71·3	2·4	1·8	1625
Buckwheat.	12·6	10	2·2	64·5	8·7	2·0	1480

[1] *Farmers' Bulletin* No. 298. Indian Corn.

TABLE XVII

MEALS AND FLOURS FROM VARIOUS CEREALS (from Hutchison).

Meal	Water per cent.	Protein per cent.	Fat per cent.	Carbohydrates per cent.	Cellulose per cent.	Min. Matter per cent.	Calorie per lb.
Wheat meal	12·1	12·9	1·9	70·3	1·6	1·2	1625
,, flour .	13·0	9·5	0·8	75·3	0·7	0·7	1610
Oatmeal . .	7·2	14·2	7·3	65·9	3·5	1·9	1795
Rolled Oats .	7·2	15·4	7·2	64·8	3·5	1·9	1790
Barley Meal	11·9	10·0	2·2	71·5	1·8	2·6	1605
Pearl Barley	12·7	7·4	1·2	76·7	0·8	1·2	1615
Coarse Rye Flour	11·4	15·3	2·1	66·7	2·3	2·2	1610
Ditto finest	11·2	6·7	0·9	80·0	0·8	0·4	1650
Maize Meal	11·4	8·5	4·6	72·8	1·4	1·3	1705
,, ,, fine	12·5	6·8	1·3	78	0·8	0·6	1630
Buckwheat Flour	14	7·1	1·2	75·9	0·6	1·2	1590
Rizine (flaked rice)	11·7	7·9	0·5	79·5	—	0·4	1645

The comparison of flours obtained by different ways of treating the wheat grain is one from which it is exceedingly difficult to draw conclusions. It has been pointed out by more than one authority on the subject that the white flour from two different varieties of wheat will sometimes show more variation than the white and whole-meal flour from the same variety. The difficulties increase when we pass on to bread; in which the water content may vary so much as to modify the protein content more than any other factor. Lastly, the digestibility of the protein in the different parts of the wheat grain is not the same. It is hoped that the various tables subjoined will lead readers to draw their own conclusions on a somewhat controversial point. At any rate they will cease to give credence to violent

statements about the non-nutritiveness of white bread, and the marvellous nutritive properties of whole-meal bread.

TABLE XVIII

Flours Prepared from Different Wheats in U.S.A. (see *Bulletin* 389.)

"Standard patent" flour seems to resemble our white flour; "entire wheat" belies its name, as it consists of only about three-quarters of the wheat grain; Graham flour is, however, whole-meal flour.

	Water	Protein	Fat	Carbo-hydrates	Ash
Oklahoma Wheat Flour.					
Standard Patent .	9·9	15·1	·9	73·6	·5
Entire Wheat . .	7·5	16·6	1·6	73	1·2
Graham	7·7	16·8	1·8	72·3	1·3
Oregon Wheat Flour.					
Standard Patent .	8·9	7·5	1·3	81·8	·4
Entire Wheat . .	8·7	8·3	1·7	80·4	1·1
Graham . . .	8·2	9	1·7	79·5	1·7
Minnesota Wheat Flour.					
Standard Patent .	10·5	12	1·6	75·4	·5
Entire Wheat . .	10·8	12·3	2·2	73·7	1·0
Graham . . .	8·6	12·6	2·4	74·6	1·7

It will be noticed that in each list the amount of protein, fat, and mineral matter present increases, whereas the amount of carbohydrate decreases as we pass from white to whole-meal flour. A similar set (from

Farmers' Bulletin No. 249) gives the following increase in fibrous matter present in each specimen..

	Fibre.
Patent roller process flour . .	0·3 per cent.
"Entire wheat" flour . . .	0·9 ,,
Graham flour	1.8 ,,

Bread made from these flours shows a similar gradation in content of protein and the other ingredients. For instance, the analysis of the bread made from the three different grades of flour prepared from Oregon wheat, is as follows—

Oregon Wheat Flour Bread (water free)—	Protein.	Fat.	Carbohydrates.	Ash.
Standard Patent Bread . .	16·2	1	82	·7
"Entire Wheat" Bread . .	18·1	1·8	78·8	1.6
Graham Bread . .	18·4	1·9	77·1	2·5

Reference may now be made to the Table giving the digestibility of the food materials in the different parts of a mixed diet. But for convenience the percentages for bread of various kinds are quoted here, from *Farmers' Bulletin* No. 389.

	Protein.	Carbohydrates.
Standard patent flour . .	88·6	97·7
"Entire Wheat" flour . .	82	93·5
Graham flour.	74·9	89·2

Calculating from these figures the digestible material in the Oregon wheat flour, the corrected percentages come out thus—

	Digestible Protein.	Digestible Carbohydrates.
Standard patent flour . . .	6·69	79·9
"Entire Wheat" flour . .	6·76	75·2
Graham flour	6·72	70·9

Readers anxious to obtain more figures on this subject should consult the Tables given at the end of Lusk's *Science of Nutrition*, where the "available nutrients"

—those actually digested—are given for all forms of food.

Some figures with regard to the changes undergone by flour in the conversion to bread will be useful.

TABLE XIX

BREAD. VARIOUS KINDS (from *Farmers' Bulletin* 389.)

	Water	Protein	Fat	Carbo-hydrate	Ash
Flour . . .	10·11	12·5	0·9	76·1	0·5
Bread, from Flour, Water and Yeast	36·1	9·5	0·4	53·7	0·3
Bread, with Skim Milk instead of Water	36·0	10·6	0·5	52·6	0·3

With these may be compared.

	Water	Protein	Fat	Carbo-hydrate	Ash
Rye Bread . . .	35·7	9·0	0·6	53·2	1·5
Rye and Wheat Bread	35·3	11·9	0·3	51·5	1·0
Maize Bread (johnny cake) . . .	38·9	7·9	4·7	46·3	2·2

Loss of nutritive material during cooking (from Hutchison)—

Of Protein	1·3 per cent.
Of Fat	71 „
Of Carbohydrates	3·2 „
Of total Calories . .	5 „

Alcohol present (from action of yeast).—It has been estimated that new bread contains 0·3 per cent. of alcohol. There is no appreciable quantity in stale bread.

Loss of weight in drying—

TABLE XX

(From Goodfellow: *Dietetic Value of Bread.*)

Hours	a 2 lb. loaf loses
In 12	$\frac{2}{7}$ oz. water.
,, 24	$\frac{2}{3}$ oz. ,,
,, 36	$1\frac{3}{5}$ oz. ,,
,, 48	$2\frac{1}{2}\frac{4}{5}$ oz.
,, 60	$3\frac{1}{2}$ oz. ,,
,, 72	$4\frac{1}{2}$ oz. ,,

Relative quantity of crust and crumb.—This naturally varies with the baking, as well as with the size of loaf. The following table was given for German bread by Birnbaum in 1878

TABLE XXI

	Weight of Loaf	Percentage Crumb	Percentage Crust
I . . .	about 14 oz.	55·2	44·8
II . . .	,, 31 ,,	59·7	40·3
III . . .	,, 63 ,,	64·3	35·7
IV . . .	,, 70 ,,	71·2	28·8

TABLE XXII

Analyses of Patent Breads (selected from Hutchison, *Food and Dietetics*).

Bread	Water	Protein	Carbo-hydrates + Fats	Mineral Matter
V.V.	40·4	7·5	51·6	0·6
Maltina (white) . . .	44·5	5·9	48·9	0·7
Nevill . . .	37·5	7·2	54·6	0·7
Manhu. . . .	42·6	7·2	48·9	1·3
Triticumina . . .	43·6	7·3	47·6	1·5
Nevill Wheatmeal .	41·5	8	49·3	1·2
Maltina (brown) . . .	45·1	7	46	1·9
Daren (malted)	46·6	7·9	44·5	1
Cytos (containing germ and malt) .	42·3	8·1	48·3	1·3
Bermaline .	38	8·1	50·3	1·9
Hovis (brown) .	45	9·9	42·3	1·2
Veda	24·6	9·4	63·5	1·8

Overleaf rice is compared with other grains. Apropos of the discussion on p. 19, the following analysis of polished and unpolished rice (also from Hutchison) will be interesting :—

	Water.	Protein.	Fat.	Carbo-hydrates.	Cellulose	Mineral Matter.
Rice (husk removed)	12·0	7·2	2·0	76·8	1·0	1·0
.. (polished) . .	12·4	6·9	0·4	79·4	0·4	·5

TABLE XXIII

Analyses of Various Preparations from Wheat; to which a few similar materials are added for comparison. Most of these are quoted by Hutchison from work by Ballard.

	Water	Protein	Fat	Carbohydrate	Cellulose	Ash Calories	
Macaroni (average)	11·8	10·9	0·6	75·9	0·3	·6	1636
Vermicelli (average)	10·4	12·1	0·8	75·6	0·33	·8	1665
Pâtes d'Italie .	10·4	12·5	0·8	75·2	0·3	·8	1665
Semolina (average)	9·7	12	0·7	76	0·5	·6	1660
Rice	12·4	7·4	0·4	79·2	0·2	0·4	1620
Sago	14·2	0·2	0·2	86·7	0·2	0·1	1620
Tapioca . .	12·8	0·3	0·2	88	0·1	0·1	1685
Cornflour (from maize) .	10	—	—	90	—	—	1670
Hominy (from maize) . .	10	8·6	0·6	79·2	0·4	0·3	1680
				Soluble / Insoluble			
Force (as eaten) .	9·3	9·4	1·4	11·4 / 65·7	—	2·9	1665
Grape Nuts (as eaten) . . .	6·2	12·0	0·6	42·7 / 36·5	—	2·0	1720

The above mentioned foods from cereals (except Force and Grape Nuts) cannot be fairly compared with bread, unless we have analyses of their composition when cooked, as a small quantity of each suffices for a helping, when swollen in bulk by the process of cooking. Macaroni absorbs about 5 times its volume of water, rice about 3 times.

The following analyses are due to Miss K. Williams, and date from about 1895, when the methods of analysis for protein and carbohydrates were not quite the same

as those of more recent statistics; but the water content will be comparable with the latter.

TABLE XXIVA

Cooked with water	Water	Protein	Fat	Carbo-hydrates	Cellu-lose	Ash
Vermicelli .	87·1	2·4	0·01	10·8	0·07	0·13
Semolina .	90·2	1·9	0·08	7·2	0·04	0·13
Hominy. . .	86·6	2·8	0·09	9·9	0·16	0·02
Sago. . .	89	1·4	0·004	9·4	0·01	0·08

The following are from Lusk's Tables (*Science of Nutrition.*)

TABLE XXIVB

	Water	Protein	Fat	Carbo-hydrates	Cellu-lose	Calories
Oatmeal,[1] cooked .	84·5	2·3	0·5	11·3	0·5	285
Rice, cooked .	72·5	2·3	0·1	23·8	0·2	505
Macaroni . . .	78·4	2·3	1·4	15·6	1·0	405

It will be observed that cooked rice, weight for weight,

[1] In these analyses the material evidently absorbs as much water as it will and the rest is drained away. In cooking porridge 4 oz. oatmeal to a pint of water seems a usual allowance; and the resulting liquid is said to be 18–20 per cent. water (*Bulletin* 249); whereas the water in the above analysis is only 15·5 per cent. The same bulletin allows only ½ oz. oatmeal to a pint to make gruel, the resulting mixture being 98 per cent. water. But Rowntree makes gruel with 2 oz. oatmeal to 1 pint water; and this is, or was formerly, the workhouse recipe for gruel. Workhouse porridge is 3 oz. to the pint. Stirabout is 3 oz. Indian meal, 5 oz. oatmeal in 2½ pints of water boiled down to 1½ pints (See Burney Yeo; *Food in Health and Disease*, 1896).

has a much greater fuel value than cooked oatmeal, and contains less water.

VEGETABLES

TABLE XXV

Roots and Tubers (from *Farmers' Bulletin* No. 295).

The nitrogenous material here is not always protein; some vegetables, notably the artichoke, contain compounds of nitrogen which are not true proteins, and do not take the same place in food value. The amount of waste is stated in round numbers as an average. It must be noted that the analyses are for the edible portion after the waste has been removed.

Vegetable	Refuse	Edible Portion						
		Water	Nitrogenous Matter	Fat	Carbohydrate	Fibre	Ash	Calories per lb. [doubtful.]
Artichoke, Jerusalem [1]	20·0	78·7	2·5	0·2	17·5	0·8	1·1	380
Beet [2] .	7·0	87·5	1·6	0·1	8·8	0·9	1·1	200
Celeriac . . .	20	84·1	1·5	0·4	11·8	1·4	0·8	265
Carrots, Fresh [3]	20	83·2	1·1	0·4	8·2	1·1	1·0	190
,, desiccated	—	3·5	7·7	0·6	80·3	—	4·9	1660
Parsnips [4] .	20	83·0	1·6	0·5	11	2·5	1·4	255
Potatoes [5] .	20	78·3	2·2	0·1	18·4	—	1·0	385
Radishes .	—	91·8	1·3	0·1	5·1	0·7	0·1	125
Salsify . . .	25	85·4	4·3	0·3	17·1	2·3	1·0	410
Turnips—								
White [6] . .	20	89·6	1·3	0·2	6·8	1·3	1·1	160
Yellow . .	20	88·9	1·3	0·2	7·3	1·2	1·3	170
Kohlrabi .	20	91·1	2·0	0·1	4·2	1·3	1·3	120
Onions . . .	10	87·6	1·6	0·3	9·1	0·8	0·6	210
Garlic . . .	—	64·7	6·8	0·1	27·9	0·8	1·5	650

Notes to Table XXV.

(1) The percentage of water in a boiled Jerusalem artichoke was estimated by Miss K. Williams as 91·6.

(2) The analysis of cooked beetroot is as follows. Water 88·6, Nitrogenous material 2·3, Fat 0·1, Carbohydrates 7·4, Ash 1·6, Calories 185.

(3) When carrots are boiled in water the loss of mineral and nitrogenous matter, also of sugar, is very large; the amount depending on the size of the pieces into which they are cut.

	Nitrogenous matter lost per cent.	Sugar lost per cent.
Small pieces	40	26
Medium Pieces	27	26
Large pieces	20	15

(*Bulletin* 45, U.S.A. Department of Agriculture.)

Miss Williams gives 93·4 as the percentage of water in cooked carrot.

(4) Miss Williams' estimate of percentage of water in boiled parsnip is 97·2.

(5) Similar experiments of hers on potatoes gave the interesting result that boiled in their skins they lost a little water—percentage decreased from 75 to 73·8. Boiled in the ordinary way it increased from 75 to 76·3. In the table below it will be seen that other specimens lost a little water in ordinary cooking. Very elaborate experiments have been made by the U.S.A. Agriculture department on the boiling of potatoes (*Bulletin* No. 43). The general conclusions were—

Potatoes boiled *without peeling*, 1 per cent. of nitrogenous matter, no starch and about 3 per cent mineral matter lost.

Potatoes peeled, put directly into hot water and rapidly boiled, 16 per cent. of nitrogenous matter and 19 per cent. mineral matter lost. (Nitrogenous matter reduced from 1·8 to 1·5.) Potatoes peeled and *soaked in cold water*, 46–48 per cent. nitrogenous matter (including 25 per cent. protein), and 38 per cent. mineral matter lost (Nitrogenous matter reduced to 0·9).

From the same bulletin we learn that the actual skin of the potato, and the layer immediately under the skin, contain a larger proportion of protein and of mineral constituents than the rest of the tuber, and a smaller proportion of starch. It is experienced by every one that to preserve the mineral constituents of the potato, by cooking in the skin, greatly improves its flavour. The amount of protein in this food is inconsiderable

in any case, so that there need not be very great stress on the loss. It has been calculated that the quantity lost by cooking a bushel of potatoes in the ordinary way is about the same as the protein in 1 lb. of beefsteak.

Analyses of potatoes cooked in various ways are given in another *Farmers' Bulletin*, No. 295. See Table XXVI.

(6) Percentage of water in cooked turnip 97·2.

TABLE XXVI

POTATOES.

	Water per cent.	Protein per cent.	Fat per cent.	Carbo-hydrates per cent.	Fibres per cent.	Ash per cent.	Calories per lb.
Potatoes (as purchased)	62·6	1·8	0·1	13·8	0·9	0·8	300
Edible part	78·3	2·2	·1	18·0	·4	1·0	375
Boiled .	75·5	2·5	·1	20·0	·6	1·0	415
Mashed, with butter, etc.	75·1	2·6	3·0	17·8		1·5	505
Potato Chips	2·2	6·8	39·8	46·7		4·5	2675

TABLE XXVII

Green Vegetables.

This table is for English vegetables, and is taken chiefly from Hutchison and also from Tibbles. The amount of refuse is not given; 10 to 15 per cent. may be allowed for most in the list. As in the last table, the nitrogenous matter is not all protein, notably so in the case of asparagus.

Vegetable	Water per cent.	Nitrogenous Matter per cent.	Fat per cent.	Carbohydrates per cent.	Cellulose[2] per cent.	Ash per cent.	Calories per lb. [doubtful.]
Asparagus, raw.	91·7	[2·2]	0·2	2·9	2·1	0·2	
Cabbage—							
Raw .	89·6	1·8	0·4	5·8	1·1	1·3	165
Cooked[1]	97·4	0·5	0·02	0·7	0·7	0·2	23
Savoy, raw .	87	3·3	0·7	6	1·1	1·6	200
Red, raw	90	1·8	0·2	5·8	1·2	0·7	150
Brussels Sprouts	93·7	1·5	0·1	3·4	5	1·3	95
Greens, Curly Kale.	82·9	3·8	0·9	8·9	1·5	3·5	275
,, Turnip Tops	88	2·5	—	3·8	3·9	1·8	115
Cauliflower . .	90·7	2·2	0·4	4·7	1·2	0·8	145
,, Cooked	96·4						
Spinach. . .	90·6	2·5	0·5	3·8	0·9	1·7	120
,, Cooked	98						
Sea-kale .	93·3	1·4	—	3·8	0·9	0·6	97
,, Cooked	98	0·4	—	0·3	1·1	0·2	13
Leeks . . .	91·8	1·2	0·5	5·8	—	0·7	150
Vegetable Marrow	94·8	0·06	0·2	2·6	1·3	0·5	48
,, Cooked	99·2	0·09	0·04	0·2	0·4	0·05	6

[1] The *Bulletin No* 45 already quoted makes the following statement:—"In 100 lb. of uncooked cabbage there are but $7\frac{1}{2}$ lb. of dry matter, and of this dry matter from $2\frac{1}{4}$ to 3 lb. are lost in the process of cooking. This loss seems to be unavoidable unless the cabbage is cooked in such a manner that the water in which it is boiled is also used."

See overleaf.

TABLE XXVIII

Salads (from Hutchison).

	Water	Nitrogenous Matter	Fat	Carbohydrates	Cellulose[1]	Ash	Calories
Celery . . .	93·4	1·4	0·1	0·9	0·9	0·9	85
„ Cooked	97·0	0·3	0·06	0·5	1·0	0·5	17
Cucumber .	95·9	0·8	0·1	2·1	0·5	0·4	70
„ Cooked	97·4	0·5	0·02	0·7	0·7	0·2	22
Endive . .	94	1·0	—	3	0·6	0·8	40
Lettuce . .	94·1	1·4	0·4	2·6	0·5	1·0	105
„ Cooked	97·2	0·5	0·2	0·5	0·9	0·4	27
Tomatoes . .	91·9	1·3	0·2	5·0	1·1	0·7	105
„ Cooked	94·1	1·0	0·2	0·1	1·5	0·7	29
Watercress . .	93·1	0·7	0·5	3·7	0·7	1·3	88

To this may he subjoined—

Mushrooms. .	91	3·8	0·2	3·5	0·8	0·5	144

[1] The increase in the percentage of cellulose after cooking, noticed in these Tables, is caused by the decrease of percentage of the soluble constituents—proteins, carbohydrates and mineral matters, which all pass into the water to a greater or less extent when the vegetables are boiled. The cellulose is insoluble, so does not decrease in quantity. The study of the figures for cooked vegetables certainly points the moral that they ought to be "conservatively" cooked—in other words cooked so as to conserve all their food material, not dissolve it into water which is afterwards thrown away.

TABLE XXIX

PULSES.

The figures given for the most important of the pulses—lentils, haricot beans and dry peas—show some amount of variation. One investigator (Ballard) gives the range between which his estimates lay, so his results will be given first. No distinction seems to be made between Egyptian (the small red) and German (the large greenish-brown) lentils.

Ballard's results.

	Water	Protein	Fat	Carbo-hydrates	Cellu-lose	Ash
Haricot Beans.	10–20·4	13·8–25·1	1–2·3	58·9–61	2·5–4·6	2·4–4·2
Lentils .	11·7–13·5	20·3–24·2	·6–1·5	56·1–62·4	3–3·6	2·9–5·5
Peas . .	10·6–14·2	18·9–23·5	1·2–1·4	56·2–61·1	2·9–5·5	2·3–3·5

In the following list averages are given. They are chiefly from Hutchison.

Pulse	Water per cent.	Protein per cent.	Fat per cent.	Carbo-hydrates per cent.	Cellu-lose per cent.	Min. Matter per cent.	Calories per lb.
Green Peas, shelled .	78·1	4·0	0·5	16	0·5	0·9	392
Dried Peas [1]	13·0	21·0	1·8	55·4	6·0	2·6	1494
Pea Flour . .	10·2	28·0	2·0	56·9	0·4	2·5	1660
Dry Broad Beans	8·4	26·4	2·0	58·6	1·0	3·6	1662
Butter Beans (ground) .	10·5	20·6	2·0	62·6	—	4·3	1628
"Haricots Verts" [2]	89·5	1·5	0·4	7·3	0·6	0·7	180
String Beans Amer. analysis .	89·2	2·3	0·3	7·4	2·8	0·8	192
Haricots [3] (dry white)	12·1	22·7	2·1	57·7	4·2	3·4	1580
Scarlet Runners.	91·1	1·7	0·3	3·7	2·9	0·3	113
Lentils [3] .	11·1	23·8	1·7	57·7	2·8	3·2	1684

TABLE XXX

Fruit.

In which, for convenience, Rhubarb (stalks) is included. The great majority of these analyses are from Hutchison; the remainder from *Farmers' Bulletin* No. 293. Wherever possible the English analyses have been preferred, as more suitable for English fruit; but the column headed Refuse is American, and therefore not as a rule from the same analysis. The acidity of certain

[1] Cooked dried peas contain about 74 per cent. water. Miss Williams gives 73·7, almost the same, for cooked haricot beans. No figure has been found for lentils; but 74 per cent. may be assumed.

[2] This seems to be the French Beans served whole like scarlet runners, not the fresh green kidney beans (served without their pods), often known as "haricots verts." The American analysis of "string bean" is put next for comparison. Compare also scarlet runners below.

[3] Mean of Hutchison's and Tibbles' figures

fruits was the subject of a special German investigation, quoted by Hutchison. Fruits with more than 80 per cent. of water are sometimes classified as flavour fruits; those with less as food fruits. Bananas and grapes come under the latter heading.

The olive is included, with its unusual content of fat. The appearance of fat in the analyses of most fruits seems to be due generally to the wax in the skin (the bloom) or to the nature of the colouring matter.

Fruit	Refuse	Water	Protein	Fat extracted by ether	Carbohydrates	Cellulose	Ash	Acid	Calories
Apples . . .	[25·0]	82·5	0·4	0·5	12·5	2·7	0·4	1·0	260
Apricots . .	[6·0]	85	1·1	—	12·4	—	·5	1·0	250
Bananas . .	[35·0]	74	1·5	0·7	22·9	0·2	·9		480
Blackberries	—	88·9	0·9	2·1	2·3	5·2	·6		145
Cherries .	[5·0]	84	·8	·8	10·0	3·8	·6	1·0–1·5	300
Cranberries .	—	86·5	·5	·7	3·9	6·2	·2	2–2·5	120
Currants (three kinds)	—	85·2	·4	—	7·9	4·6	·5	1·4	155
Figs (Fresh) .	—	79·1	1·5	—	18·8		·6		380
Gooseberries .	—	86	0·4	—	8·9	2·7	·5	1·5	170
Grapes . . .	[25·0]	79	1·0	1·0	15·5	2·5	·5	0·5	350
Greengages .	—	80·8	0·4	—	13·4	4·3	·5	—	290
Lemons .	[30·0]	89·3	1·0	·9	8·3	—	·5	—	210
Lemon Juice . .	—	90·0	—	—	2·0	—	·4	7·0	35
Medlar . . .	—	74·6	0·5	0·3	16·5	7·5	·6	—	330
Melon . . .	—	89·8	·7	·3	7·6	1·0	·6	—	165
Water Melon	—	92·9	·3	·1	6·5	—	·2	—	130
Mulberries . .	—	84·7	·3	—	11·4	0·9	·6	1·8	220
Nectarines .	[6·6]	82·9	·6	—	15·9	—	·6	—	305
Olives .	[17·9]	67	2·5	17·1	5·5	3·3	4·4	—	1470
Oranges . .	[27·0]	86·7	0·9	0·6	8·7	1·5	·6	1–2·5	205
Orange Juice .	—	85	—	—	10·8	—	—	1·9	200
Peaches . .	[18·0]	88·8	0·5	0·2	5·8	3·4	0·6	1·0	110
Pears	[10·0]	83·9	·4	·6	11·5	3·1	·4	·1	220
Pineapples	[40·0]	89·3	·4	·3	9·7	?	·3	—	190
Plums . .	[5·0]	78·4	1·0	—	14·8	4·3	·5	—	290
Pomegranates .	[?]	76·8	1·5	1·6	16·8	2·7	·6	—	405
Raspberries .	—	84·4	1·0	—	5·2	7·4	·6	—	115
Rhubarb Stalks	[40·0]	94·4	0·6	0·7	2·5	1·1	·7	—	85
Strawberries . .	[5·0]	89·1	1·0	·5	6·3	2·2	·7	1–1·2	160
Whortleberries or blaeberries or bilberries .	—	76·3	0·7	3·0	5·8	12·2	·4	1·6	245
DRIED FRUITS.									
Apples .	—	36·2	1·4	3·0	49·1	4·9	1·8	3·6	1065
Currants .	—	27·9	1·2	3·0	64	1·7	2·2	—	1335
Dates . .	—	20·8	4·4	2·1	65·7	5·5	1·5	—	1390
Figs . .	—	20	5·5	0·9	62·8	7·3	2·3	1·2	1305
Prunes . . .	—	26·4	2·4	·8	66·2	—	1·5	2·7	1365
Raisins . .	—	14	2·5	4·7	74·7	—	4·1	—	1630

	Refuse	Water	Protein	Fat	Carbohydrates	Fibre	Ash	Calories
TINNED FRUITS (American).								
Apricots	—	81·4	0·9	—	17·3	—	0·4	337
Cherries	—	77·2	1·1	0·1	21·1	—	·5	414
Peaches	—	88·1	0·7	·1	10·8	—	·3	213
Pears . .	—	81·1	·3	·3	18·0	—	·3	341
Pineapples	—	61·8	·4	·7	36·4	—	·7	712
CANDIED FRUIT (American).								
Angelica .	—	10·4	0·1	0·1	87·3	1·5	0·6	1625
Cherries	—	12·1	·5	·2	86·1	0·6	·6	1617
Ginger . . .	—	12·3	·3	·2	86·1	·7	·4	1610

JAM, MARMALADE, HONEY

It was mentioned in Chapter I that fruit always contains some sugar of a different kind from cane or beet sugar; one name for it is fructose, as it comes from fruit. When cane sugar is boiled with dilute acid some of it is converted into fructose and kindred sugars; the longer it boils the more complete is the change. Therefore, jam always contains some amount of the newly formed sugars, home-made jam usually more than commercial jam, as it has been boiled longer. As practically all the nutriment in jam is in the sugar content, analyses are usually estimates of the amounts of the different sugars. Further, a sugar allied to fructose, known as glucose, is often added to commercial jam instead of cane sugar, because it can be made artificially at small expense. Glucose has quite as satisfactory fuel value as fructose, and there is not much objection to it if it does not bring undesirable impurities. In minor details, such as consistency and behaviour on further cooking, it does not seem to be quite the same thing in use. Analysts distinguish amongst these sugars by their action on polar-

ized light, and are accustomed to describe the fructose and kindred sugars obtained in the boiling of the cane sugar as "Invert" sugar, borrowing this term from the technical nomenclature concerned with polarization. Very few analyses are available which give the protein content, but it is always well under 1 per cent.; the total sugar is from 50 to 60 per cent. HONEY consists of about 20 per cent. water, 74 per cent. of sugars (chiefly of the nature of fructose) and some quantity of other carbohydrates such as dextrin.

An analysis of ORANGE MARMALADE (American) on ordinary lines is :—

Water.	Protein.	Fat.	Carbohydrates.	Ash.	Calories
14·5	0·6	0·1	84·5	0·3	1580

A few samples of Wiley's[1] analyses of jams on the other method are subjoined. Jams vary in their acidity, as is seen in these; they also vary in the amount of cellulose as fibre contained, blackberry and bilberry jam having a comparatively large quantity; also in the amount of water—where strawberry generally has the most.

TABLE XXXI

	Water per cent.	Acidity per cent.	Invert Sugar per cent.	Cane Sugar per cent.	Total Sugar per cent.
JAM (American.)					
Apple	36·8	0·28	25·5	29·1	54·6
Blackberry	44·6	·85	18·8	29	47·8
Pineapple	26·1	·31	14·1	46·4	60·5
Plum . .	49·6	1·01	28·3	9·7	38·0

[1] *Food and its Adulterations.*

Also some samples given in the *Analyst*, quoted by Tibbles.

	Water	Invert Sugar	Cane Sugar	Other Solids	Skins & Seeds	Ash
Average of Home-Made Jam .	30·5	53·1	6·7	4·8	4·3	·5
Average of Commercial Jam .	29·5	35·6	27·8	3·1	3·5	·4

Among "other solids" will come Pectin, the substance (allied to a carbohydrate) which causes jams to set as a jelly. In some commercial jams of the inferior kind gelatin, or some form of starch like cornflour or tapioca, is added to make the jam solid and jelly-like, if there is deficiency of pectin. But turnips, for instance, contain a fair amount of pectin, although not as much per cent. as do fruits such as the apple, lemon or gooseberry.

NUTS

TABLE XXXIIa.

From *Farmers' Bulletin* No. 332.

		Edible Portion.						
Nut	Refuse	Water	Protein	Fat	Carbohydrates	Fibre	Ash	Calories
Almond . .	47	4·9	21·4	54·4	13·8	3·0	2·5	2895
Brazil Nut. .	49·4	4·7	17·4	65	5·7	3·9	3·3	3120
Chestnut, Fresh	15·7	43·4	6·4	6·0	41·3	1·5	1·4	1140
Coco-nut . .	34·7	13	6·6	56·2	13·7	8·9	1·6	2805
„ desiccated	—	3·5	6·3	57·4	31·5		1·3	3125
„ Milk	—	92·7	0·4	1·5	4·6		0·8	155
Filbert (dry)	52·1	5·4	16·5	64	11·7		—	—
Pea Nut .	27·0	7·4	29·8	43·5	14·7	2·4	2·2	2610
Pine Nuts, shelled .	—	6·2	33·9	48·2	6·5	1·4	3·8	2710
Walnut (dry) .	58·8	3·4	18·2	60·7	13·7	2·3	1·7	3075

TABLE XXXIIB.

a set of English analyses of nuts from Hutchison, is subjoined to show the extent of variation in the same species of nut. These analyses are of shelled nuts.

	Water	Protein	Fat	Carbo-hydrates	Cellu-lose	Mineral Matter
Chestnuts, Fresh .	38·5	6·6	8	45·2		1·7
Walnuts, Fresh .	44·5	12	31·6	9·4	0·8	1·7
„ Dried	4·6	15·6	62·6	7·4	7·8	2
Filberts and Hazels–						
Fresh . .	48	8	28·5	11·5	2·5	1·5
Dried .	3·7	14·9	66·4	9·7	3·2	1·8
Almonds . . .	6	24	54	10	3	3
Brazil Nuts .	5·0	17·0	67·2	7·0		4·0
Pea Nuts . . .	9·3	27·9	42·0	18·7		2·1
Coco-nut, fleshy part .	46·6	5·2	35·9	8·4	2·9	1
„ milk .	90·3	0·5	—	9		—

BEVERAGES

The following table is given in the *Farmers' Bulletin* No. 249 for comparison of the "coffee" made from roasted cereal grains with ordinary coffee, tea and cocoa; the latter are put first here in the list.

TABLE XXXIII

Beverage	Water	Protein	Fat	Carbo-hydrates	Calories per lb.
Tea, ·5 oz. to pint .	99·5	0·2	—	0·6	15
Coffee, 1 oz. to pint	98·9	0·2	—	0·7	16
Cocoa, ·5 oz. to pint	97·1	0·6	0·9	1·1	65
Cocoa ·5 oz. to one pint milk	84·5	3·8	4·7	6·0	365
Skim Milk .	90·5	3·4	0·3	5·1	170
"Cereal" Coffee .	98·2	0·2	—	1·4	30
Parched Corn Coffee	99·5	0·2	—	0·5	13
Oatmeal Water, 1 oz. to pint	99·7	0·3	—	0·3	11

It may be observed that Rowntree (see Appendix T to *Poverty*) makes *two* of the three typical beverages so that they are distinctly weaker than the American specimens.

Tea . .	·2 oz. to pint		
Coffee .	·4 ,,	,,	of which ·08 is chicory
Cocoa . .	·5 ,,	,,	the same as above

DIGESTIBILITY OF PROTEINS, FATS AND CARBOHYDRATES

Chalmers Watson gives the following generalized result.

In a mixed diet

Of Protein . . .	91·3	per cent. is digested
,, Fat . .	95·9	,, ,,
,, Carbohydrates	97·7	,, ,,

On an exclusively vegetarian diet the percentage of protein is somewhat less.

Dividing the mixed diet into three headings, he gives

TABLE XXIV

	Animal Foods.	Cereals and Sugars.	Vegetables and Fruits.
Protein	98	85	80
Fat	97	90	90
Carbohydrates	100[1]	98	95

TABLE XXXV

Coefficient of Digestibility of the different classes of Cereals and of a few other foods

From *Farmers' Bulletin* No. 249.

	Percentage Digested			Percentage available Calories
	Protein	Fat	Carbo-hydrates	
Oat products	77·9	90·0 (computed)	97	87·8
Wheat Products—				
Undecorticated	72·7	90·0	91	83·3
Decorticated	80·9	,,	95·6	89·3
Rolled, partly cooked	83·1	,,	93·1	86·1
Malted, ready to eat.	75·4	,,	91·4	84·7
Rye products				
Barley products	77·8	,,	93·8	86·4
Buckwheat products				
Rice products	88	,,	98	92
Graham Bread	76	,,	91	83
"Entire Wheat" Bread	82	,,	94	87
White Bread	88	,,	98	92
Macaroni	86·8	,,	97·4	92·1
Legumes	78	,,	97	80
Potatoes	73	,,	99	91
Beefsteak	98	,,	98	98

[1] Milk sugar only: except a little glycogen in liver.

CHAPTER VI

THE USE OF THE TABLES

Analyses of Made Dishes, of Daily Diets, and of Weekly Consumptions.

Owing to the peculiar conditions of the time, tables or calculations involving the prices of food can be of very little use. All reference to price has therefore been omitted. Current prices can hardly be considered stable; and inferences based on pre-war prices are of little use to us, as the increase of price is not evenly distributed among the common articles of food.

In comparing two articles of food and determining their relative value, there is not, unfortunately, one criterion, but two criteria—two separate ways of judging them. One is by the protein content, the other by the fuel value. In each case one is to have in mind either the amount of protein, or the number of Calories needed by each person daily. As a secondary consideration a food may be judged according to its contribution of fat and carbohydrate; but we have seen that one of these may be substituted for the other, as long as we take into account their different calorific value.

Another difficulty in comparing foods is that dry articles, which absorb a good deal of water when cooked, cannot in all circumstances be compared fairly with other articles which take up but little, or even lose, water in cooking. The housewife in her weekly purchases can correctly compare the value of 1 lb. of lentils with 1 lb. of butcher's meat, as she will arrange to have both consumed fully by the family. She may judge

in the same way that ½ lb. of lentils will give a more valuable meal for a family of six than ½ lb. butchers' meat. But what she cannot do is to offer a single hungry person, instead of the ½ lb. meat which he would readily eat, ½ lb. of lentils cooked so that they had swollen to 1½ or 2 lbs. of rather monotonous food. Nor would he take ½ lb. of oatmeal, which would mean at least a quart of thick porridge.

Examples in working out the value of cooked food are given in the next chapter.

With regard to all calculations, the reader is advised to resolve to work out a fairly large number of her individual problems, if she begins to use the tables at all, for, naturally, it is only practice that makes them easy or rapid; the first three or four will take some little time, both in looking up the data and doing the calculation. But after a few have been done, it will be found that such ingredients as flour, eggs, sugar, milk, occur so often that the figures for them are easily memorized, and altogether the whole operation becomes much more rapid.

Approximate results may always be obtained by cutting off the decimal place given in these tables, given because it is customary. Thus 11·4, the percentage of protein in flour, may be written as 11; 74·8 the percentage of carbohydrate as 75. (This is on the principle that up to ·5 the figure is simply omitted; above ·5, 1 is added to the unit in front when the decimal is omitted.) Considering the variation in the composition of flour, and indeed in the composition of most articles of food, to deal thus with our figures seems quite justifiable; and it shortens the work greatly to have two figures in each item instead of three. The majority of the examples given are, however, worked out from the Tables as given;

but one or two abbreviated ones are given for illustration and comparison.

The percentage numbers give the *proportion* of protein, etc., in the food; as they stand they are not weights at all. The number 11·4 above states that $\frac{11 \cdot 4}{100}$ or $\frac{114}{1000}$ of the sample of flour was protein. Therefore of 1 oz. flour ·114 *oz.* was protein; of 1 lb. flour ·114 *lb.* was protein. At the beginning of the calculation we must decide whether we are going to work in decimals of a lb. or decimals of an oz. The former will be found better for weekly dietaries, the latter for made dishes. The weekly dietaries will finally have to be converted into ounces when they are reduced to the daily amount per head. It must be remembered that the Calories or fuel values are always given for pounds, and those for ounces must be got by division. The reader will find it exceedingly useful to memorize the *sixteen times table*, if she does not know it already. The constant use of it will soon make it easy to remember.

In tabulating the value of a given weight of any food, look up the percentages in the Tables, and copy them down with the decimal point moved two places to the left. This will convert them from percentages into decimals of an ounce or pound, whichever you require, (as in the last paragraph). The figures are then ready to be multiplied by the number of ounces or pounds of the food.

Thus—for the food value of 6 lb. of flour—to be given in lbs.

	% ÷ 100					
	P.	F.	C.	Protein.	Fat.	Carbohydrate.
6 lb. flour . .	114	[a]·01	·748	·684	·010	4·488 lb.

Note carefully at (*a*) the appearance of a zero directly

after the decimal point when we have to express only 1 per cent. of fat, as a decimal of a pound and the decimal point has to be moved *two* places to the left. In The right hand column ·060 is written instead of ·06. The final 0 is of course unnecessary, but it will be found helpful to put it in, so as to have three decimal figures in each item,—to keep them all in the proper place for addition.

I. TYPICAL RECIPES

A. Soups.

1. Tomato Soup for six persons. (Mrs. Beeton.)

	% ÷ 100			Ounces of			Calories
	P.	F.	C.	Protein	Fat	Carbohydrates	
Tomatoes, 2 lb. (32 oz.)	·009	·004	·039	·288	·048	1·248	210
Butter, 1 oz. . . .	—	—	—	·010	·830	—	220
Sago, 1 tablespoonful (1 oz.)	—	—	—	·002	·002	·860	100
1 Onion, 1 Carrot (12 oz.)	·013	·003	·080	·156	·036	·960	138
Stock, 1 quart weak, (40 oz.) . .	·012	·015	—	·480	·600	—	210
or Water (1 quart), Ham (2 oz.)							
			6)	·936	1·516	3·068	878
	Per portion			·156	·253	·511	146
[Ham, (2 oz.)	·145	·332	.	·290	·664	—	209]
Subtracting the quantities for stock and adding those for ham we get			6)	·746	1·580	3·068	877
	Per portion . .			·124	·263	·511	146

The substitution of ham does not alter the fuel value, which is remarkable, but gives more fat and less protein.

2. Tomato Soup. (Another recipe.)

	% ÷ 100			Ounces of			Calories
	P.	F.	C.	Protein	Fat	Carbohydrates	
Tomatoes, (2 lb.)	—	—	—	·288	·048	1·248	210
Stock, $1\frac{1}{2}$ pints (30 oz.)	—	—	—	·360	·450	—	159
Butter, (2 oz.)	·01	·83	—	·020	1·660	—	440
Flour, 1 oz.	—	—	—	·114	·010	·748	103
Milk, $\frac{1}{2}$ pint (10 oz.)	—	—	—	·330	·400	·500	201
			6)	1·112	2·568	2·496	1113
	Per portion			·185	·428	·416	185

3. Potato Soup for six persons. (Mrs. Beeton.)

	% ÷ 100			Ounces of			Calories
	P.	F.	C.	Protein	Fat	Carbohydrates	
Stock, 40 oz. (as above)	—	—	—	·480	·600	—	210
Milk 10 oz. (as above)	—	—	—	·330	·400	·500	201
Potatoes, 1 lb.	·018	·001	·147	·288	·016	2·352	310
Butter, 1 oz.	—	—	—	·010	·830	—	220
Sago, 1 tablespoonful (1 oz.)	—	—	—	·002	·002	·860	101
1 Onion, 1 stick Celery (8 oz.)	—	—	—	·104	·024	·640	92
			6)	1·214	1·872	4·352	1134
	Per portion			·202	·312	·725	189

B. Meat Dishes.

1. Stewed Steak for four persons. (Mrs. Beeton.)

	% ÷ 100			Ounces of			Calories
	P.	F.	C.	Protein	Fat	Carbohydrates	
Steak (rump), 16 oz. .	·152	·186	—	2·432	2·976	—	1065
Butter (1 oz.) . .	—	—	—	·010	·830	—	220
Flour, etc., 1 oz. .	—	—	—	·114	·010	·748	103
Carrots, Turnips, etc. 8 oz. . . .	·013	·003	·08	·104	·024	·640	92
			4)	2·660	3·840	1·388	1480
Per portion				·665	·960	·347	370

2. Toad in the Hole for four persons. (Mrs. Beeton.)

	% ÷ 100			Ounces of			Calories
	P.	F.	C.	Protein	Fat	Carbohydrates	
Steak, 16 oz.	—	—	—	2·432	2·976	—	1065
Flour, 4 oz.	·114	·010	·748	·456	·040	2·992	412
Milk, etc., 10 oz. . .	—	—	—	·330	·400	·500	201
Egg, 1 (2 oz.)	·119	·093	—	·238	·186	—	76
			4)	3·456	3·602	3·492	1754
Per portion				·86	·9	·873	438

3. Hot Pot for eight persons. (Mrs. Beeton.)

	% ÷ 100			Ounces of			Calories
	P.	F.	C.	Protein	Fat	Carbohydrates	
Beef, Lean, 2 lb. (32 oz.)	·192	·092	—	6·144	2·944	—	1490
Potatoes, 3 lb. (48 oz.)	·018	·010	·147	·864	·480	7·056	930
Onions $\frac{1}{2}$ lb. (8 oz.) .	·013	·030	·800	·104	·240	·640	92
			8)	7·112	3·664	7·696	2512
				·889	·458	·962	314

The same with abbreviated figures, to two decimals instead of three.

	% ÷ 100			Ounces of			Calories
	P.	F.	C.	Protein	Fat	Carbohydrates	
Beef, 2 lb.	·19	·09	—	6·08	2·88	—	—
Potatoes, 3 lb. .	·02	·01	·15	·96	·48	7·2	—
Onions, $\frac{1}{2}$ lb. . .	·01	·03	·80	·08	·24	·64	—
			8)	7·12	3·60	7·84	2512
				·89	·45	·98	314

C. Puddings.

1. Suet Pudding for six persons. Plain. (Mrs. Beeton.)

	% ÷ 100			Ounces of			Calories
	P.	F.	C.	Protein	Fat	Carbohydrates	
Flour, 8 oz.	·114	·01	·748	·912	·08	5·984	825
Suet, 4 oz. . .	·047	·818	—	·108	3·272	—	885
			6)	1·020	3·352	5·984	1710
Per portion .				·170	·559	·997	285

2. Sponge Pudding for six persons (?) (Mrs. Beeton.)

	% ÷ 100			Ounces of			Calories
	P.	F.	C.	Protein	Fat	Carbohydrates	
Flour, 12 oz.	·114	·01	·748	1·368	.12	8·976	1237
Suet, 4 oz.	—	—	—	·108	3·272	—	885
Golden Syrup, 8 oz.	·024	—	·693	·192	—	5·544	665
Milk, ½ pint (5 oz.) . .	·033	·04	·05	·165	·200	·250	100
			6)	1·833	3·592	14·770	2887
Per portion .				·305	·599	2·461	481

3. Windsor Pudding for five persons. (Mrs. Beeton.)

	% ÷ 100			Ounces of			Calories
	P.	F.	C.	Protein	Fat	Carbohydrates	
Apples, 2 lb. . .	·004	·005	·125	·128	·160	4·000	520
Castor Sugar, 1 oz.	—	—	—	—	—	1·000	112
Rice, 1 oz. . .	—	—	—	·074	·003	·792	101
Milk (to boil rice), 4 oz.	·033	·04	·05	·132	·160	·200	80
Egg-whites, 4 . =·58 of 8 oz., see p. 66 =4·64 say 4½ oz.	·123	·002	·006	·553	·009	·027	65
			5)	·887	·332	6·019	878
				·177	·066	1·204	176

4. Sago Pudding for two persons (?)

	Ounces of			Calories
	Protein	Fat	Carbohydrates	
Milk, ½ pint (10 oz.)	·330	·400	·500	200
[1] Sago, 1 oz. . . .	·002	·002	·860	101
[1] Sugar, 1 oz. . .	—	—	1·000	112
2)	·332	·402	2·36	413
Per portion .	·166	·201	1·18	206

[1] There is a good deal of variation in the starch and sugar content of these milk puddings, according to taste. An egg will increase notably the content of protein and fat; rice instead of sago will give more protein. It seems safe to allow ¼ pint milk to each portion.

5. Stewed Apples, for six persons (?)

	Ounces of			Calories
	Protein	Fat	Carbo-hydrates	
Apples, 2 lb.	·128	·160	4·000	520
Sugar, ¼ lb.	—	—	4·000	447
6)	·128	·160	8·	967
	·021	·027	1·33	161

6. Stewed prunes for six persons (?) (*Cassell's Dictionary.*)

	% ÷ 100			Ounces of			Calories
	P.	F.	C.	Protein	Fat	Carbo-hydrates	
Prunes, 1 lb. (16 oz.)	·024	·008	·662	·384	·128	10·592	1365
Sugar, ¼ lb. (4 oz.). .	—	—	—	—	—	4·000	447
			6)	·192	·064	14·592	1812
				·032	·011	2·432	302

D. Vegetarian Dishes (Food Reform Association.)

1. Semolina Cheese for six persons. (From *Econ. Dishes for Workers.*)

	% ÷ 100			Ounces of			Calories
	P.	F.	C.	Protein	Fat	Carbohydrates	
Semolina, 6 oz.	·12	·007	·76	·720	·042	4·560	624
Milk, 1 pint (20 oz.)	—	—	—	·660	·800	1·000	402
Cheese, 8 oz.	·252	·337	·024	2·016	2·696	·192	975
Egg, 1 (2 oz.)	·119	·093	—	·238	·186	—	76
			6)	3·634	3·724	5·752	2077
				·606	·621	·959	346

2. Mock chicken cutlet for 4 persons.

	% ÷ 100			Ounces of			Calories
	P.	F.	C.	Protein	Fat	Carbohydrates	
Walnuts, shelled, 4 oz.	·182	·607	·137	·728	2·428	·548	769
Bread crumbs, 2 teacups (4 oz. ?)	·092	·013	·531	·368	·052	2·124	304
Butter, 1 oz.	—	—	—	·010	·830	—	220
[1] Milk, ¼ pint ? (5 oz.)	·033	·04	·05	·165	·200	·250	100
Egg, 1 (2 oz.)	—	—	—	·238	·186	—	76
			4)	1·509	3·696	2·922	1469
				·377	·924	·730	367

[1] "A gill" is given in the recipe, to make sauce with a teaspoonful of flour (this small amount of flour has been omitted). In the south of England a gill is usually ¼ pint, in the north it is ½ pint. The former quantity seems enough for the flour.

3. Hotch Potch. To be compared with Mrs. Beeton's Hot Pot.

The recipe is for 6 persons, and consists of $\frac{3}{4}$ lb. haricot beans, with unspecified quantities of potatoes, onions, carrots and turnips. To make comparison the amount of beans has been increased to 1lb., as sufficient for 8 persons, the same amount of potatoes and onions allowed as in the Hot Pot recipe; and in addition 1 lb carrots and turnips, also 2 oz. margarine to represent the "fat for frying" the onions and carrots.

	% ÷ 100			Ounces of			Calories
	P.	F.	C.	Protein	Fat	Carbohydrates	
Haricot Beans, 1 lb.	·231	·023	·536	3·696	·368	8·576	1520
Potatoes, 3 lb. . .	—	—	—	·864	·480	7·056	930
Onions, $\frac{1}{2}$ lb. . .	—	—	—	·104	·240	·640	92
Carrots and Turnips, 1 lb.	.013	·003	·08	·208	·480	1·280	184
Margarine, 2 oz. . .	·012	·83	—	·024	1·660	—	439
			8)	4·896	3·228	17·552	3165
				·612	·404	2·194	396

The fuel value of the vegetarian dish is greater. This is due to its larger content of carbohydrates; it is a little inferior in fat, and distinctly inferior in protein content. It will be found useful to compare the other two vegetarian dishes also with the meat and pudding dishes in B and C.

E. Old-fashioned Recipes.

It may be of interest to analyse some recipes from old cookery books, in which, as is well known, eggs and cream were used much more lavishly. It has not been easy, however, to find suitable ones, as the quantities are often quite vaguely indicated. In the case of meat dishes the joint is mentioned, but no weight given. And a further difficulty arises, because the number of persons for whom the dish is intended is not stated.

1. From Dr. Kitchener's *Cook's Oracle*, 7th edition, 1823.

Vermicelli pudding.

	% ÷ 100			Ounces of			Calories
	P.	F.	C.	Protein	Fat	Carbohydrates	
Milk, 20 oz.	—	—	—	·660	·800	1·000	402
Sugar, 2 oz. (?)	—	—	—	—	—	2·000	224
Vermicelli, 4 oz	·121	·08	·756	·484	·320	3·024	491
Eggs, 3 whole, 6 oz.	·119	·093	—	·714	·558	—	230
2 Extra Yolks = ·3 of 4 oz. = 1·2 oz.	·157	·333	—	·188	·400	—	127
				2·118	2·006	6·024	1474
If for 4 Persons—per portion				·529	·501	1·506	367
If for 6 Persons—per portion				·353	·334	1·004	246

2. From the same.

Boiled Custard.

	% ÷ 100			Ounces of			Calories
	P.	F.	C.	Protein	Fat	Carbohydrates	
Milk, 20 oz.	—	—	—	·660	·800	1·000	402
Cream, 20 oz.	·025	·185	·045	·500	3·700	·900	1160
Eggs, 6 (12 oz.)	—	—	—	1·428	1·116	—	460
Extra yolks, 4 (see last recipe)	—	—	—	·376	·800	—	254
Sugar, 4 oz.	—	—	—	—	—	4·000	448
				2·964	6·416	5·900	2724
This is about a quart of custard, so should serve 8 people—per portion				·371	·802	·737	341

Comparing these with the puddings in section C it will be seen that the first is richer in protein than any, though not in fuel value; the second is richer in protein, considerably so in fat, and in fuel value; but deficient in carbohydrates. This will generally be the case with more expensive dishes.

3. From a Cookery book "by a Lady" 1829 (used by the writer's grandmother). Compiled chiefly from eighteenth century books.

"Des Fondis" (Cheese fondue).

	% ÷ 100			Ounces of			Calories
	P.	F.	C.	Protein	Fat	Carbohydrates	
Milk, 10 oz.	—	—	—	·330	·400	·500	201
Butter, 1 oz.	—	—	—	·010	·830	—	220
Flour, ½ oz.	—	—	—	·067	·05	·374	51
Cheese. 8 oz.	·252	·337	·624	2·016	2·696	·192	975
Eggs, 8 (16 oz)	—	—	—	1·904	1·488	—	613
Cream, 10 oz.	—	—	—	·250	1·850	·450	580
				4·607	7·314	1·516	2640
The mixture was put in small cases, only half-filled. If enough for 10 people—per portion				·480	·731	·152	264

This was presumably the savoury at the end of a meal! It is remarkably rich in protein and fat, but has a very small amount of carbohydrates. Fuel value equal to a substantial pudding.

4. From the same.

A "Good" Suet Pudding.

	Ounces of			Calories
	Protein	Fat	Carbo-hydrates	
Suet, 24 oz.	·648	19·632	—	5310
Flour, 32 oz. . . .	3·648	·032	23·936	3540
Currants, 16 oz. . .	·192	·048	10·240	1335
Eggs, 6, 12 oz. . . .	1·428	1·116	—	460
Milk, 20 oz.	·660	·800	1·000	402
	6·576	21·628	35·176	11047
This pudding weighed 6½ lb. before boiling; so 24 persons should have had a 4 oz. helping from it. Per portion .	·274	·901	1·466	460

This is rather deficient in protein; but its large proportion of fat, and fairly large amount of carbohydrate make its fuel value unusually large.

We shall find great contrast—though the most striking part of the comparison would be in the price—in subjoining to these old recipes those for the cheap two-course dinners for artisan households, published by Dr. Crowley and Miss M. Cuff of Bradford in 1909. [1]

[1] Information as to the cost of living of the working classes of the W. Riding of Yorkshire, published by the Education Committee.

F. Two-Course Dinners for Man, Wife and Five Children, Average age 10 (equivalent to 4·8 adults.)

1. Yorkshire Cheese Pudding and Bean Gravy (No. 8).

Buttered Rice.

	% ÷ 100			Ounces of			Calories
	P.	F.	C.	Protein	Fat	Carbohydrates	
Milk, 20 oz.	—	—	—	·660	·800	1·000	402
Eggs, 2 (4 oz.)	—	—	—	·476	·364	—	153
Flour, 8 oz.	—	—	—	·912	·080	5·984	825
Cheese, 8 oz.	—	—	—	2·016	2·696	·192	975
Margarine, 1 oz.	—	—	—	·012	·830	—	220
Beans, 4 oz.	·231	·023	·536	·924	·092	2·144	380
Onion and Carrot, 4 oz.	—	—	—	·052	·012	·320	46
			4·8)	5·052	4·874	9·640	3001
Per portion				1·050	1·015	2·010	625
Rice, 6 oz.	·074	·003	·792	·444	·018	4·752	607
Sugar, 2 oz.	—	—	—	—	—	2·000	224
Margarine, 2 oz.	—	—	—	·024	1·660	—	440
			4·8)	·468	1·678	6·752	1271
Per portion				·097	·350	1·407	265
The Whole Meal				1·147	1·365	3·417	890

2. Fish and Potato Pie with Sauce. Green peas (dried.)

Blancmange and Jam (No. 11).

	% ÷ 100			Ounces of			Calories
	P.	F.	C.	Protein	Fat	Carbohydrates	
Fish, 2 lb., without bone	·184	·043	—	5·888	1·376	—	1052
Potatoes, 3 lb.	·018	·001	·147	·864	·048	7·056	930
Margarine, altogether 3 oz.	—	—	—	·036	2·490	—	660
Flour, 2 oz.	—	—	—	·228	·020	1·496	206
Milk, 5 oz.	—	—	—	·165	·200	·250	100
Peas, 12 oz.	·226	·017	·532	2·712	·204	6·384	1098
Sugar, 1 oz.	—	—	—	—	—	1·000	112
			4·8)	9·893	4·338	16·186	4158
Per portion .				2·061	·904	3·372	866
Cornflour, 2 oz.	—	—	·9	—	—	1·800	209
Sugar, 1 oz.	—	—	—	—	—	1·000	112
Milk, 25 oz.	—	—	—	·825	1·000	1·250	503
Jam, 4 oz.	—	—	—	·024	·004	2·440	286
			4·8)	·849	1·004	6·490	1110
Per portion .				·177	·209	1·352	231
Whole Meal				2·237	1·113	4·724	1197

The second is an altogether larger meal than the first. In the pamphlet a week's menus are given, and a certain average for the week is the aim of the writers.

It may be useful to compare with this a meal selected from Mrs. Beeton's recipes, consisting of tomato soup, stewed steak and ordinary boiled potatoes, sago pudding and stewed apples.

	Ounces of			Calories
	Protein	Fat	Carbo-hydrates	
(3) Tomato Soup	·156	·261	·511	146
Stewed Steak. .	·665	·960	·347	370
Potatoes, 4 oz.	·060	·040	·588	77
Sago Pudding	·166	·201	1·180	206
Stewed Apples .	·032	·011	2·432	302
	1·079	1·473	5·058	1101

This is equal to the second in fuel value, but very inferior to it in protein, in which, however, it is equal to the first.

It is rather important to work out the food value of the chief meal of the day, and then to determine whether another "substantial" meal (which generally means a meal rich in protein) must be supplied. If an ordinary adult consumes 12 oz. bread and 1 oz. butter at the smaller meals, and 1 oz. jam ; ½ pint of milk and 1 oz. sugar in beverages, these will add up to—

Ounces of			
Protein	Fat	Carbo-hydrates	Calories
1·450	1·387	8·482	1516

	Protein	Fat	Carbo-hydrates	Calories
With Meal No. 1. .	2·610	2·737	11·892	2414
,, ,, ,, 2. . .	3·687	2·496	13·206	2632
,, ,, ,, 3. . .	2·529	2·860	13·540	2617

The amount still to be made up depends, of course, on the standard of diet selected, whether of low or high

protein; but it will be observed that No. 2 is the only one which could possibly do with very little more protein; it might have most of the remaining Calories made up with fat, starch or sugar. This is the one containing cheese and beans (no meat and no fish), but as it throws more strain on digestion than the latter would, it could not be repeated very often. With the other two diets another meal fairly rich in protein should be supplied; one with eggs, cheese, pulses, or more meat.

Some interesting work has been done in both Bradford and Edinburgh [1] in trying to fix a standard content of nutriment for children's school dinners. It has been assumed that the allowance of protein and fat at this, their chief meal, should be liberal; as in the remaining part of their meals the cheaper carbohydrates are likely to predominate. The standard at Bradford is 29 gr. protein, 18 gr. fat, or just over 1 oz. protein, ·635 fat. If the average child fed takes ·5 of a man's allowance, this is equivalent to giving a man 2 oz. protein, 1·27 oz. fat at a meal. The standard at Edinburgh is about the same in protein, but half the quantity of fat. It is desirable to collect more observations and calculations on this subject.

II. DIETARIES FOR A SINGLE DAY

Several are quoted by Hutchison from an early Bulletin by Atwater, and are worked out fully, to show that each gives about 125 grams protein and 3500 Calories. The food (which is American), is given in daily rations, not meals, and on the whole has not much variety in the ingredients, not as much as one would get in an ordinary household. The actual weight of food

[1] Chalmers Watson, *Book of Diet.*

consumed varies from 30 oz. to 71 oz., i.e. from 2½ lb. to nearly 4½ lb., the average being about 3 lb. An ordinary diet for an adult is usually between 3 and 4 lb. per diem.

The following daily diet has been given in various treatises, for example in Newsholme's *Hygiene*, 1902.

	% ÷ 100			Ounces of			Calories
	P.	F.	C.	Protein	Fat	Carbohydrates	
Bread, 1 lb. (16 oz.) .	·092	·013	·531	1·472	·208	8·496	1215
Meat, ½ lb. (8 oz.). .	·145	·161	—	1·160	1·288	—	456
Eggs, 2 (4 oz.) .	·119	·093	—	·476	·372	—	153
Cheese, ⅛ lb. (2 oz.) .	·252	·337	·024	·504	·674	·048	244
Fat (butter), ¼ lb. (4 oz.)	·01	·83	—	·040	3·320	—	877
Potatoes, 1 lb. (16 oz.)	·018	·001	·147	·288	·016	2·352	310
Milk, ½ pint (10 oz.) .	·033	·040	·050	·330	·400	·500	201
				4·246	6·278	11·396	3456

The protein is about 121 grams, close to Atwater's standard, but the amount of fat is very large, and would be some tax on the digestion.

2. From p. 64 of *Dietetics* by Dr. A. Bryce (see Books for Reference). Some of the items, such as bread and butter, are added together instead of divided into separate meals. For made dishes, such as tomato soup and sago pudding, a single helping according to Mrs. Beeton's recipes is substituted for the weight he gives as a helping of the mixture.

	% ÷ 100			Ounces of			Calories
	P.	F.	C.	Protein	Fat	Carbohydrates	
Banana, $3\frac{1}{2}$ oz.	·013	·006	·021	·045	·021	·073	100
Cooked Cereal, $\frac{3}{4}$ oz.[1]	—	—	—	·020	·011	·090	17
Milk, 6 oz.	·033	·04	·05	·198	·240	·300	121
Bacon, 2 oz.	·095	·594	—	·190	1·188	—	336
Egg, 2 oz.	·119	·093	—	·238	·186	—	77
Marmalade, $\frac{1}{4}$ oz.	·006	·001	·845	·001	—	·211	25
Sugar, 1 oz.	—	—	—	—	—	1·000	112
Bread, 9 oz.	·092	·013	·531	·828	·117	4·779	684
Butter, 1 oz.	—	—	—	·010	·830	—	220
Cream, $\frac{1}{2}$ oz.	·025	·185	·045	·012	·092	·022	28
Tomato Soup, one portion	—	—	—	·156	·261	·511	146
Beef, cooked, 4 oz. (as U.S.A.)	·223	·286	—	·892	1·144	—	405
Potatoes, 3 oz.	·015[2]	·001	·147	·045	·003	·441	58
Cauliflower, 3 oz.	·014	·002	·048	·042	·006	·144	27
Sago Pudding (one portion)	—	—	—	·166	·201	1·180	206
Prunes	—	—	—	·032	·011	2·432	302
Cheese, $\frac{1}{4}$ oz.	·252	·337	·024	·063	·084	·006	30
Biscuit, $\frac{1}{4}$ oz.	·107	·088	·719	·027	·022	·180	30
Fish, 5 oz.	·184	·043	—	·920	·215	—	165
Apples, stewed, one portion	—	—	—	·021	·027	1·330	161
				3·906	4·659	12·696	3250

[1] Taking porridge as 8 oz. oatmeal to 1 qt. (40 oz.) water, 48 oz. porridge contains P. 1·288, F. ·704, C. 5·752. If no allowance is made for loss of water 1 oz. contains P. ·027, F. ·015 C. ·120; $\frac{3}{4}$ oz. is an unusually small helping.

[2] As these potatoes are probably peeled and put into cold water, at least 16 per cent of the protein was lost; therefore ·015 is substituted for ·018.

Though this diet appears very moderate in the separate quantities the total shows that, according to the highest

standards, it is ample, or too much for a man of sedentary habits. The amount of fat is very large—over $4\frac{1}{2}$ oz. Perhaps we should treat the small percentages of "fat" derived from vegetables and fruits as somewhat illusory, but subtracting them would leave the total well over 4 oz.; though the fish was considered to be white fish with a comparatively small fat content.

It is not easy to obtain samples of daily diets, except peculiar ones undertaken for experiment, and a collection of specimen diets taken by ordinary people under ordinary conditions would be very helpful.

The dieteticians in the United States have advanced much farther than any one else in the direction of systematic estimation and tabulation of the actual food eaten, so as to give, very readily, approximation to the amount of nutriment taken. Dr. Irving Fisher [1] divides food into portions, each of which supplies 100 Calories. Amongst them are—

A large slice of Bread (about $1\frac{1}{3}$ oz. probably).
One Egg (a large one (?).
One Potato (size not stated).
4·9 oz. Milk (practically $\frac{1}{4}$ pint).
A small piece of Cooked Beef (sirloin).
An "ordinary pat" of Butter.
1 Banana.
1 dozen Almonds.
1 dozen Oysters.
5 teaspoonfuls Sugar.

Some of the quantities are unfortunately a little vague, if they cannot be actually seen. The content of protein, etc., is of course very varied. The oysters, egg and beef stand highest in protein, butter, almonds

[1] Chittenden. *Nutrition of Man.*

and beef in fat. The sugar is naturally highest in carbohydrates, as it contains nothing else; bread comes next, of these selected specimens.

A special interest attaches at present to soldiers' daily rations. Very strict regulations have been promulgated for them under ordinary peace conditions by War Office authorities, medical and otherwise. Unfortunately during peace time and in normal service a soldier's allowance does not cover the whole of his daily food. He gets—

	Protein	Fat	Carbo-hydrates	Calories
Meat, 12 oz. . . .	1·740	1·932	—	744
Bread, 16 oz. . . .	1·472	·208	8·496	1215
	3·212	2·140	8·496	1959

This of course is far from being a complete diet. The usual allowance for groceries and vegetables seems to have been most frequently 3*d.* per day before the war, which seems very little, especially as tea, milk and sugar will be the first necessary items.

A Government Report on the rations of soldiers in various nations of Europe was published in 1889; from this it appeared that the English allowance of meat was the largest, and the bread one of the smallest in Europe.

The Field Ration, for "active operations in the field" is given in detail in the Regulations for the Allowances of the Army, and is analysed below. It is subject to modification by climate and circumstances. The "iron ration," which is portable, is not given, as it is presumed to be an emergency rather than a daily diet.

	% ÷ 100			Ounces of			Calories
	P.	F.	C.	Protein	Fat	Carbohydrates	
Meat, 20 oz. (beef)	·152	·155	—	3·040	3·100	—	1169
Bread, 20 oz.	·092	·013	·531	1·840	·260	10·620	1519
Bacon, 4 oz.	·095	·594	—	·380	2·376	—	671
Cheese, 3 oz.	·252	·337	·024	·756	1·011	·072	366
Peas or Beans, 2 oz. (mean)	·228	·02	·534	·456	·040	1·068	186
Jam, 4 oz.	·006	·001	·61	·024	·004	2·440	286
Sugar, 3 oz.	—	—	—	—	—	3·000	336
				6·496	6·791	17·200	4533

This is a very ample allowance in every way. Colonel Melville [1] made a report to the British Medical Association in 1910 of experiments on soldiers' rations while on active service, from which he deduced the necessity of a large allowance of protein and of fat, when the men had to undergo unusual fatigue, exposure, and long hours without food. He recommended about 6·7 oz. protein, though not so much fat as in the above ration; with a minimum of 4,000 Calories.

III. WEEKLY BUDGETS

1. This is taken from the book entitled *The Pudding Lady*. It is the weekly purchases of a working woman who had profited by the lessons of the "Pudding Lady" (Miss Florence Petty).

The family consisted of man, wife and two children, whose ages are not stated.

[1] *British Medical Journal*, 1910.

Man	1·0
Woman	·8
One child	·6
Another child	·4
Total	2·8 Adults

The meat seemed to be cheap but very sensibly chosen and cooked, so the average food value is allowed for it. Tea and coffee are omitted, as of negligible food value.

	% ÷ 100			Pounds.			Calories
	P.	F.	C.	Protein	Fat	Carbohydrates	
Meat, 9 lb. (cheap, but well chosen). .	·145	·161	—	1·305	1·499	—	8217
Bread, 17 lb. . .	·092	·013	.531	1·564	·221	9·027	8645
Flour, 4 lb.	·114	·010	·748	·456	·040	2·992	6600
Milk, 1 tin (1 lb. ?).	·090	·135	·515	·090	·135	·515	1691
Sugar, 2½ lb. .	—	—	—	—	—	2·500	4475
Butter, ¾ lb. .	·01	·830	—	·007	·627	—	2633
Suet, 2 oz..	·047	·818	—	·006	·102	—	442
Carrots, 3 lb.	·013	·003	·08	·039	·009	·240	552
Onions, 3 lb. .	·013	·003	·08	·039	·009	·240	552
Greens, 1 lb. . .	—	—	—	·014	·002	·048	145
Potatoes, 16½ lb.	·018	·001	·147	·297	·016	2·425	5115
Cocoa, ¼ lb. .	·216	·289	·377	·054	·072	·094	580
Fish, ½ lb.	·184	·043	—	·092	·022	—	263
			7	)3·963	2·754	18·081	39910
				·566	·393	2·583	5701
			28	)5·661	3·934	25·830	57014
				·202	·140	·922	2036
						16	
				3·232	2·240	14·752	

This dietary is seen to be inadequate in every particular.

[1] See note to next table.

2. This budget was drawn up by a working woman who was attending a School for Mothers. It was awarded a prize in a competition in an evening paper, the outlay being 15*s.*, at prices immediately before the

	% ÷ 100			Pounds			Calories
	P.	F.	C.	Protein	Fat	Carbohydrates	
Meat, $6\frac{1}{2}$ lb. .	·145	·161	—	·942	1·046	—	5934
Sausages, 1 lb. .	—	—	—	·123	·210	·011	1132
Flour, 3 lb. .	·114	·01	·748	·342	·030	2·244	4950
Bread, 14 lb. .	·092	·013	·531	1·288	·182	7·434	17010
Milk, $8\frac{3}{4}$ lb. (7 pts.).	·033	·04	·05	·289	·350	·440	2713
Eggs, 12, $1\frac{1}{2}$ lb. .	·119	·093	—	·178	·139	—	919
Sugar, 3 lb. . .	—	—	—	—	—	3·000	5370
Margarine, 1 lb.	—	—	—	·012	·830	—	3520
Dripping, 1 lb. .	—	—	—	·022	·940	—	4000
Suet, $\frac{1}{2}$ lb. .	·047	·818	—	·023	·409	—	1770
Bacon, $\frac{3}{4}$ lb.	·095	·594	—	·071	·445	—	2014
Cheese, $\frac{3}{4}$ lb. .	·252	·337	·024	·189	·253	·018	14[illegible]2
Oatmeal, 2 lb.	·161	·074	·652	·322	·148	1·304	3518
Herrings, $\frac{1}{2}$ lb.	·112	·039	—	·056	·019	—	181
Other fish, $1\frac{1}{2}$ lb.	·109	·024	—	·163	·036	—	442
Rice, 1 lb. . .	—	—	—	·074	·004	·792	1620
Haricot Beans, 1 lb.	—	—	—	·231	·023	·536	1520
Jams, 2 lb.	·006	·001	·61	·012	·002	1·220	2290
Potatoes, 8 lb.	·018	·001	·047	·144	·008	·376	2480
			7)	4·481	5·034	17·375	62845
Daily diet .			[1]3·3)	·6401	·719	2·4821	8977·9
Per adult . . .				·194	·218	·752 16	2721
Ounces . . .				3·104	3·488	12·032	

[1] To divide by 3·3, 2·8 and similar numbers with one decimal. It is advisable for greater accuracy, though not necessary, to carry the division by 7 one decimal place further (giving the Calories one decimal place). Then move all the decimal points

War. The compiler showed much ingenuity and resource in getting reduced prices for meat and eggs. Some articles were not given in quantity, but only their cost; the quantity was deduced from the prices current at the time. The family was a man, wife and three children, ages not stated. Taking each child as ·5 of a man the total represents 3·3 adults.

This is a fuller diet than the last one, but the Calories are not enough for a man at manual labour, and the same is probably true for the other members of his family. The supply of fat seems adequate, but the protein is not quite 90 grams; either that, or the carbohydrates, or both, needs substantial increase. There are no vegetables other than potatoes.

3. The following weekly budget was given in an anonymous letter published in *The Times* of October 6, 1915, to show the rise in prices in the first year of the War. It included figures for consumption of gas and for laundry which are omitted. It is not given in so much detail as the previous budget, smaller expenses being classed together. There are several curious, omissions, possibly of materials of which the price had not increased. These are potatoes and other vegetables fat other than butter (possibly the fat supplied in the ample allowance of meat was sufficient), and jam. The use of 6 lb. of flour weekly points to making puddings or cakes which would require fat. It may be included

one place to the left, and proceed to divide by 33, 28, etc. as whole numbers. Factors can often be taken, as 3 and 11, 7 and 4, and short division used. Thus with this dietary

11)6·401	7·19	24·821	8977·9
3) ·582	·654	2·256	8162
·194	·218	·752	2721

under "pudding materials," and jam also included here. The last drawback to the budget is that it is for "five persons, one a child," the sexes not stated. However, it does give the main items of expenditure of a family in or near London of the professional class.

We must fix first the number of adult men to which the family is equivalent. If the four adults are one man and three women (it is probably a two-servant household), and the child is taken as ·6 of a man, we have $1+3\times{\cdot}8+6=4$ adult men exactly. If there are two men and two women the total would be 4·2. But this assumes that the men take all their meals at home, which is very unlikely. On the other hand, two servants might perhaps each be counted as ·9 of a man, if the mistress is ·8, as they do much more manual labour. We will give the result of both divisions :—

	% ÷ 100			Pounds of			Calories
	P.	F.	C.	Protein	Fat	Carbohydrates	
Meat, 13 lb. (pre-war price, 11½*d.*)	·145	·161	—	1·885	2·093	—	11869
Bread, 20 lb.	·092	·013	·531	1·840	·260	10·620	24300
Flour, 6 lb.	·114	·01	·748	·684	·060	4·488	9900
Eggs, 12 (1½ lb.)	·119	·093	—	·178	·139	—	919
Milk, 11 quarts (27½ lb.)	·033	·04	·05	·907	1·100	1·375	8855
Butter, 2 lb.	·01	·83	—	·020	1·660	—	7020
Bacon, 2 lb.	·095	·594	—	·190	1·188	—	5370
Cheese, 1½ lb.	·252	·337	·024	·378	·505	·036	2925
Fish (pre-war price, 2*s.* 3*d.*), 3½ lb. as sold	·109	·024	—	·381	·084	—	1032
Sugar, 5 lb.	—	—	—	—	—	5·000	8950
Beer and Stout, 1 doz. qts. =30 lb.	·006	—	·013	·180	—	·390	1050

	% ÷ 100			Pounds of			Calories
	P.	F.	C.	Protein	Fat	Carbohydrates	
Cocoa, ½ lb. (Tea and Coffee omitted)	·216	·289	·377	·108	·144	·188	1160
Deduced from the following items:— Pudding material, stewed fruit = 2*s.* 3*d.* (pre-war.) Cakes, fruit, salad, condiments = 4*s.* (pre-war.)							
Rice, 4 oz.	·074	·003	·792	·018	·001	·198	405
Sago. 4 oz.	·002	·002	·860	—	—	·215	402
Fruit, 4 lb.	·004	·005	·080	·016	·020	·320	800
Salad, 1 lb.	·001	—	·030	·001	—	·030	65
Cake, 1 lb.	·063	·090	·633	·063	·090	·633	1670
Dry Fruit, 8 oz.	·018	·038	·693	·009	·019	·347	740
And added—							
Potatoes, 10 lb.	·015	·010	·147	·150	·100	·1470	3100
Green vegetables 2 lb.	·014	·002	·048	·028	·004	·096	290
Onions, etc. 1 lb.	·013	·003	·080	·013	·003	·080	184
Total 7)				7·049	7·470	25·486	90996
Daily consumption 4)				1·007	1·067	3·641	13000
Per adult man				·252	·267	·910 16	3250
In ounces				4·032	4·272	14·560	3250
Division by 4·2 instead of 4 gives Ounces				3·840	4·069	13·867	3095

Even the lower numbers give a quite ample diet on the Atwater standard, with a large proportion of fat. In fact the numbers are unnecessarily high for an adult man doing sedentary work. But they are not at all

discrepant with Dr. Bryce's daily diet for a professional man (see p. 115). One is of course always struck by the much greater variety of food possible in the more expensive diet.

BUDGET OF WEEKLY PURCHASES FROM LETTER IN *Times*. Calculations Abbreviated. Calories are omitted as they are the same.

	% ÷ 100			Protein	Fat	Carbohydrates
	P.	F.	C.			
Meat, 13 lb.	·15	·16	—	1·95	2·08	—
Bread, 20 lb.	·09	·01	·53	1·80	·20	10·62
Flour, 6 lb.	·11	·01	·75	·66	·06	4·50
Eggs, 1½ lb.	·12	·09	—	·18	·14	—
Milk, 27½ lb.	·03	·04	·05	·82	1·10	1·38
Butter, 2 lb.	·01	·83	—	·02	1·66	—
Bacon, 2 lb.	·01	·59	—	·02	1·18	—
Cheese, 1½ lb.	·25	·34	·02	·38	·51	·03
Fish, 3½ lb.	·11	·02	—	·38	·07	—
Sugar, 5 lb.	—	—	—	—	—	5·00
Beer, 30 lb.	·01	—	·01	·30	—	·30
Cocoa, ½ lb.	·22	·29	·38	·11	·14	·19
Rice, ¼ lb.	·07	—	·79	·02	—	·20
Sago, ¼ lb.	—	—	·86	—	—	·21
Fruit, 4 lb.	—	—	·08	—	—	·32
Salad, 1 lb.	—	—	·03	—	—	·03
Cake, 1 lb.	·06	·09	·63	·06	·09	·63
Dry Fruit, ½ lb.	·02	·04	·69	·01	·02	·35
Potatoes, 10 lb.	·02	—	·15	·20	—	1·50
Greens, 2 lb.	·01	—	·05	·02	—	·10
Onions, etc., 1 lb.	·01	—	·08	·01	—	·08
				6·92	7·25	25·44
Instead of				7·067	7·470	25·346

The list of weekly purchases given is worked out above with the food values of each item taken in whole

numbers, decimals omitted (see p. 95). As the quantities are very large the results will show some appreciable difference, but the working is much easier. And we must repeat that there is nothing fixed or final about the analyses taken, they are only averages. The new figures are all a little less; the fat particularly. This is because the very small percentage of fat in such articles as fruit and salad has not been taken in. But all the results as they stand would be quite accurate enough for the general conclusions drawn from these dietaries.

Note to Second Edition. The writer is fully convinced that calculations, such as these in the preceding chapter, will serve all ordinary purposes if the abbreviated figures, without decimals, are taken for the percentage content in protein, fat and carbohydrate. The more accurate figures will be necessary only when food problems on a larger scale, as in catering for large numbers, are being solved.

CHAPTER VII

MISCELLANEOUS CALCULATIONS

I. How to Calculate Calories from Analyses giving only Protein, Fat, Carbohydrates.

A. The fuel value of a given dish or portion of a dish.

One portion of sponge pudding (p. 101) contains Protein ·305 oz., fat ·599 oz., carbohydrates 2·461. What is its fuel value? The protein and carbohydrates are added together, as they have the same multiplier—116 for each oz.

The multiplier for the fat is 263.

It is very easy to multiply by 116; but in the other case usually easier to make the other number the multiplier. After doing a few calculations, the product of 263 and any of the units, from 2 to 9, is easily memorized, or a note may be kept of them. If there is no abbreviation the results will be given to 3 decimal places, whereas only whole numbers are required for Calories. Readers who are familiar with approximations for multiplication by decimals will make their own approximations. Others may be contented with striking off the last figure from the decimal quantities given.

Protein	·305	Fat	·599
Carbohydrates	2·461		263
	———		60
	2·766		———
			157·80
Take	2·77		
	116		
	———		
	321·32		
	157·80		
	———		
	479·12.	Total Calories=479	

Calculated in full this gives 478·39.

B. To find the fuel value per lb. when the analysis of a sample of the material is given.

This is often the case in the works of older authorities, as the constant reference to fuel values is comparatively recent.

The method is similar to the above, but the percentage numbers of the analysis are first divided by 100, and then treated as decimals of 1 lb. They have therefore to be multiplied by new factors, 16×116 in one case, 16×263 in the other; or 1856 and 4208. Or we can if we like perform the multiplications as above, and then multiply the total result by 16 to convert Calories per oz. into Calories per lb.

Another way is to take approximate multipliers, and use 1860, and 4210. First multiply by 10, and then use 186 and 421 as multipliers.

Example. The percentage composition of biscuit

is given in Appendix G, Rowntree's *Poverty*, as—Protein 8·7, Fat 2·6, Carbohydrates 55·3. What is its fuel value per lb.?

[N.B. The fat content of biscuit is extremely variable; this is very low. An American cracker has about 9 per cent., and many English biscuits have more.]

Per lb.

Protein	·087	Fat.	·026
Carbohydrates	·553		
	·640		

These numbers are to be multiplied by 10 however, so they would have been better copied down with the decimal point moved *one* place to the left, not two.

Protein	·87	Fat	·26.
Carbohydrates	5·53		
	6·4		
	186		421
	6·4		·26
	1190·4		109·46
	109·46		
	1299·86		

Total fuel value 1300 Calories.

This is slightly too large as both approximations have been made in the direction of increase. The more accurate working gives 1296 Calories.

If a large number of calculations have to be done

the products of 421 and 186 into all the units from 2 to 9 can be noted or memorized.[1]

II. Nutritive Ratios.

To obtain the nutritive ratio of the dish, or of the material, the Calories supplied by the Protein alone must be calculated. The ratio $=\frac{\text{Calories from Protein}}{\text{Total Calories}}$

Thus in Example *A*.—Sponge Pudding:—
Protein $=\cdot305$ oz. $=\cdot31$
Calories $=\cdot31\times116=35\cdot96=36$.

Ratio is $\frac{36}{479}$, a little more than $\frac{1}{13}$th, which is low.

In Example *B*.—Biscuit:—
Protein 8·7 per cent. $=\cdot087$ in 1 lb.
Calories $=\cdot87\times186=161\cdot82=162$.

Ratio is $\frac{162}{1300}$, a little less than $\frac{1}{8}$th.

This would satisfy those who approve of only a moderate supply of protein.

As a third example we will take a food rich in protein, such as Egg.

Protein 11·9 per cent. $=\cdot119$ in 1 lb.

$$1\cdot19\times186=221\cdot34=221$$

Ratio $=\frac{221}{613}=1$ to 2·78.

which is of course very high.

[1] Atwater gives, instead of Rubner's figures quoted on p. 22, 1 gr. protein 4 cal., 1 gr. fat 8·9 cal., 1 gr. carbohydrate 4 cal.; but these figures have not come into general use.

III. Calculations with regard to Food which Absorb a good deal of Water during Cooking.

Sometimes, as in the case of porridge (see p. 115 note) the calculation of the food value after cooking is very simple. If a weighed amount of oatmeal is put into a measured quantity of water, and a definite fraction of the whole served to each person after cooking, say $\frac{1}{6}$, we can easily determine the food value of $\frac{1}{6}$ of the original amount of oatmeal. We cannot tell the exact weight of this portion, unless we know how much water was lost during cooking. The 48 oz., consisting of 8 oz. oatmeal, 40 oz. water, will not be quite 48 oz. porridge and the sixth portion will not weigh $\frac{1}{2}$ lb.

Similarly a certain fraction of a sago pudding of specified ingredients will have definite food value. But if a person is stated to have partaken of 4 oz. of sago pudding, we cannot give the approximate value, even if we know the recipe on which it was prepared, without knowing the actual weight of the pudding after cooking. This indeed would vary with the time taken to cook it.

It has not been possible to obtain any data for the loss of weight in cooking of either baked or boiled dishes of mixed ingredients; nor of the similar loss for cakes, which would be easier to determine. Observations on this matter would be very useful and valuable.

However, some data are available for the actual composition of dry foods which have been cooked in water, and allowed to absorb as much as they can. (See Tables.) It is possible to determine from each of these a very valuable piece of information—the proportion of water

absorbed during cooking. The use of a little simple algebra is necessary.

1. Dry rice contains about 12 per cent. of water; cooked rice about 72 per cent. How much water has been absorbed?

Let 1 oz. rice absorb x oz. water, thus becoming $(1+x)$ oz. after cooking.

$\cdot 12$ oz. water $+x$ oz. water $=\cdot 72$ of $(1+x)$ oz. water

Making the decimals whole numbers

$$11+100\ x=72+72\ x$$

$$x=\frac{72-12}{100-72}=\frac{60}{28}=\frac{15}{7}=2\tfrac{1}{7}.$$

Therefore rice absorbs a little more than twice its weight of water.

2. Macaroni, dry, contains 10·3 per cent. water, cooked macaroni 78·4 per cent.

$$\cdot 103+x=\cdot 784(1+x).$$

[Here a decimal place was introduced into the original data, so we have three decimals on dividing by 100, and to get whole numbers we must multiply by 1000.

$$103+1000\ x=784+784\ x$$

$$x=\frac{784-103}{1000-784}=\frac{681}{216}=3\cdot 16$$

Macaroni absorbs a little more than three times its weight.

3. Haricot beans, dry, contain 13·6 per cent. water, cooked, 73·7 per cent.

$$136+1000\ x=737+737\ x$$

$$x=\frac{737-136}{1000-737}=2\cdot 3 \text{ nearly.}$$

They absorb between $2\frac{1}{4}$ and $2\frac{1}{3}$ of their weight.

It is hoped that the reader unversed in algebra will now see a "rule" emerging from these three examples. The proportion desired is obtained by dividing one number by a second. The first is got by subtracting the lower percentage from the higher. The second is got by subtracting the higher percentage from either 100 or 1000, according to whether you have two figures or three.

But we have not yet quite succeeded in getting this statistic in its most useful form for a cook. Practical experimenters always give the result as the *bulk or volume* of water absorbed, not the *weight*; and this is indeed the figure most often required in practice. How are we to connect one with the other?

A good deal of measurement by spoonfuls is done in cooking, instead of by weight. It is customary to consider a tablespoonful of the following to be about equivalent to an ounce—flour, fine sugar, rice and other small grains, cornflour and similar powders; but this is rather a rough estimate. In water a tablespoonful is only about half an ounce. (It is also only about half an ounce in such a light porous material as breadcrumbs, whereas the same volume of syrup or jam is about 2 oz.) This looks as if these grains and powders were about twice as heavy as water. In this case the figures obtained above will have to be multiplied by two to give the relative volume of water absorbed.

But water must be a level tablespoonful, while the powders are always "heaped" more or less. Further, the "fluid ounce" which is equal to two tablespoonfuls of water is slightly greater than the ordinary ounce. So that it would be probably nearer the truth to take $1\frac{1}{2}$ times the numbers. This would give for rice $3\frac{3}{14}$ or

$3\frac{1}{5}$ its volume, for beans $3\frac{1}{2}$ nearly, and for macaroni $4\frac{1}{2}$ or $4\frac{2}{3}$ the volume.

It seems customary among cooks to allow about 3 times the volume for rice, and about 5 times for macaroni, but no doubt a more accurate measurement would be useful.

Lastly, if one is given the increase of weight on cooking in water, the new food value is quite readily determined. Supposing 1 oz. of the food becomes $3\frac{1}{2}$ oz. after it has absorbed water, we have only to take the various food values for 1 oz. and the Calories for the same, and divide by $3\frac{1}{2}$ to get the new values per oz.

NOTES ON CHAPTER II

Fuel Values of the Three Kinds of Food (p. 22). Slightly lower figures may be used, to indicate the calories *utilised.*

	Production of Calories.	
	per gram.	per ounce.
Protein . .	4	113
Fat . . .	9	255
Carbohydrate .	4	113

VITAMINES (p 18).

The subject of Vitamines or Accessory Food Factors continues to attract the attention of the physiologists. It is increasingly important for those concerned with food, especially with feeding young children, to keep themselves acquainted with the results of research. A Report* was issued in 1919 which brings the subject up to that date, and contains a very useful Table, quoted in full below. But one of the chief authorities on Vitamines said during that year, "we are only at the beginning of the study."

Although the importance of Vitamines should be fully recognised, a word of warning is necessary against the opposite mistake of considering them all-important. When it is stated that some food is deficient in one, or even in all, these food-factors, the statement does not deny ordinary nutritive value to that food, which may nevertheless supply enough calories, when judged by the usual standard, to be a valuable source of nourishment.

Nomenclature. Hence there is some point in retaining for the present the adjective 'accessory' for the food-factors, although accessory is so inadequate a word. We are referring to substances of such a nature that their absence from our diet is likely to produce at least failure of nutrition and health, and at

*Joint Report on Vitamines by the Lister Institute and the Medical Research Committee. Special Report, No, 38. H.M. Stationery Office, Price 4s. This contains a good bibliography of the sources of information.

most, serious disease and death. But the name "vitamine" * has also been discountenanced, as vague and misleading. The matter can be properly settled only when the chemical nature of each of the substances has been determined, an achievement not yet attained, although approached.

Two vitamines are now recognised by all workers; they have been styled A and B, and are further distinguished as Fat-soluble A and Water-soluble B. Both appear to be necessary to the growth of animals and to their powers of reproduction. Experimenters directing their work towards the influence of the substances on deficiency diseases refer to the former as the anti-rachitic, the latter as the anti beri-beri or anti-neuritic factor (see p. 19).

A third, the anti-scorbutic factor, is believed to be present in the fruit and vegetable juices which ward off or cure scurvy. Doubt has been expressed by certain experimenters whether this is a definite substance which can be isolated. It is admitted to be the most elusive and least stable of the three.

Fat soluble A. It was noted in the text that animals fed on purified forms of food do not thrive if the fat supplied is one of a certain set, and thrive well if one of a certain other set is used. In the case of very young animals, some form of rickets will ensue if fats of the first category alone appear in the diet; rickets will be prevented or cured if a fat of the second category is substituted.

Substances *not* containing Fat-soluble A.	Substances containing Fat-soluble A.
Lard.	Butter.
Pork-fat.	Milk.
Olive-oil.	Egg-yolk.
Cotton-seed oil.	Oleo oil.
Coco-nut oil.	Fish oil.
Linseed oil.	Codliver oil.

The substance is contained also in green vegetables, and to some extent in the cereal grains, chiefly in their germs or embryos. These facts are of the greatest importance in considering what fats are most suitable in our diet. But practical aspects will be discussed after the full Table for the occurrence of vitamines has been given.

* Prof. Halliburton writes :—"The very term Vitamine is a source of fallacy. . . . . When we say that vitamines are vital constituents of diet we ought to mean that they are indispensable, and not imply that the vitamines possess the characters connoted by the word life." *Lancet*, 1914, Vol I, p. 931.

Water soluble B. This is the substance which is removed from rice in the process of polishing it. Investigation shows that it resides in the rice germ, which is removed in this process, as well as in the last thin covering of husk, to remove which is the object of polishing. What is true of rice is true of all cereal grains ; the germ and the bran supply this food-factor. It is also contained in pulses, but in these it is evenly distributed throughout the seeds. Eggs and milk possess it. The fact that seeds, grains, milk and eggs are furnished with water-soluble B. shows that it must be essential for the growth of young organisms both animal and vegetable. Ordinary vegetables, including potatoes, contain it in a lesser degree, and so does fresh meat. An attempt has been made to express quantitatively the relative efficacy of these materials. (see Report table III.)

Relative Value in the natural condition for the Prevention of Beri-beri.

Wheat germ taken as	100
Wheat bran	25
Rice germ	200
Yeast (pressed)	60
Peas (dried)	40
Lentils	80
Egg-yolk	50
Ox-liver	50
Beef muscle	11
Potatoes	4·3

Isolation. Attempts to isolate this vitamine and ascertain its chemical nature are more advanced than is the case with the others. One authority has given the following figures for its occurrence in rice-polishings, an unusually rich source. From 25,000 grams polishings, 0.2 to 0.25 gr. were obtained ; in another instance 0.25 gr. only from 35,000 grams. These amounts, giving at most a percentage occurrence of 0.01, are probably too large, as the substance was not completely isolated. Bayliss in his Physiology (Edition 1918, p. 254), observes that the addition of 3 cc. of milk per day to the diet of a rat fed with artificial food causes it to grow at the rate of 0.5 gr. per day. The total solid content of this amount of milk is only .08 gr. and probably only a small percentage of this is effective for growth. In the case of this anti-beri-beri vitamine there are

some grounds for believing that the actual quantity required to prevent the disease will prove to be in proportion to the food consumed, i.e., an amount sufficient for a moderate diet of rice would not be sufficient if the amount were considerably increased.

Action of Heat. Both Fat-soluble A. and Water-soluble B. withstand the action of heat, up to the boiling-point of water. Processes of drying such as are carried on in producing dried milk and dried egg do not destroy either of them. It is also stated that butter kept in cold storage does not suffer diminution in its content of fat-soluble A. But exposure for some time to the temperature of 120° C. lessens very greatly, and seems finally to destroy both vitamines. Thus foods preserved by the ordinary methods of tinning or canning will not be good substitutes for similar fresh ones, as far as accessory factors are concerned.

Anti-scorbutic Faotor. The difficulties in getting some sort of fresh food during a sea voyage have now so greatly diminished that scurvy among sailors is much less common. It seems probable also that the introduction of potatoes practically put an end to the prevalence of scurvy epidemics on land. It has, however, been found by experiment that a form of it will appear in young animals fed exclusively on dried milk, and that infants on the same diet run a risk of scorbutic symptoms. Also, there were several local outbreaks of scurvy duriog the war due to the lack of potatoes and green vegetables, outbreaks similar to those during the potato famine in Ireland in 1847.

Research has shown that various food stuffs will prevent or cure scurvy in certain animals, and that their relative power to do so varies greatly. Fresh milk contains only just enough of the necessary substance; summer milk from cows fed on fresh herbage is better than winter milk when they get no green stuff. Infants nourished on *dried* milk require as adjunct an anti-scorbutic food such as the raw juice of oranges, swedes or tomatoes. Ordinary cooking seriously diminishes the efficacy of the anti-scorbutic substances. Even drying at a low temperature will reduce the power of cabbage, potatoes and other vegetables almost to *nil*. The expressed juice of vegetables loses its value when kept at ordinary temperature, but the expressed juice of acid material such as fruits or sorrel leaves is more stable. Steaming vegetables is a better process than boiling, and the water from boiled vegetables should be used. It is noteworthy that the use of soda diminishes the value of green vegetables.

A table similar to the one given for Water-soluble B. for the relative value of various foods, is given in an article by Dr. Harden on this vitamine in *Physiology and National Needs*, a collection of articles published in 1918.

Fresh cabbage taken as	100
Swede-juice (raw)	40
German lentils	20
Cooked cabbage	20
Runner beans	20
Boiled potato	5
Dried vegetables	1·6
Lemon juice	66
Orange ,,	33
Lime ,,	10-15
Grape ,,	5
Meat ,,	5
Cows' milk	1

Occurrence. The anti-scorbutic factor differs from the other two in being found generally in tissues still living and carrying on chemical processes, and not in seeds, which contain chiefly reserve substances; nor does it remain when the tissue structure is destroyed by heating or drying. A remarkable fact is that the pulse seeds develop the substance during germination; so that their efficacy becomes quite notable if they have been soaked in water and kept in a warm place. Commercial lime-juice preparations are of little use. It will be seen that lemon-juice is better than lime-juice. It appears from investigation that the citric acid of these fruits does not itself contain the anti-scorbutic factor. A preparation very efficacious in preventing scurvy can be extracted from the fruit so as to be entirely free from citric acid. This preparation has proved very useful as an adjunct to a milk diet when the addition of acid is undesirable.

The following Table, from the Joint Report already mentioned, gives a comprehensive survey of the conclusions obtained by workers on the efficacy of certain food stuffs which were fed experimentally to various animals. The number of + signs used is an indication of the amount of vitamine present.

The Distribution of the Three Accessory Factors in the commoner food stuffs.

	Fat-soluble A. or anti-rachitic factor.	Water-soluble B. or anti-neuritic factor.	Anti-scorbutic factor.
Fats and Oils:			
Butter	+ + +	0	
Cream	+ +	0	
Codliver oil	+ + +	0	
Mutton-fat	+ +		
Beef-fat or suet	+ +		
Pea-nut or arachis oil	+		
Lard	0		
Olive oil	0		
Cotton-seed oil	0		
Coco-nut oil	0		
Cocoa-butter	0		
Linseed oil	0		
Fish oil, whale oil	+ +		
Hardened fats, animal or vegetable	0		
Margarine from animal fat	in proportion to amount of animal fat		
Margarine from veg. fats or lard	0		
Nut butters	+		
Meat, Fish, etc.			
Lean meat (beef, mutton, etc.)	+	+	+
Liver	+ +	+ +	+
Kidneys	+ +	+	
Heart	+ +	+	
Brain	+	+ +	
Sweetbreads	+	+ +	
Fish (white)	0	very slight if any	
Fish fat (salmon, herring, etc.)	+ +	very slight if any	
Fish roe	+	+ +	
Tinned meats	?	very slight	0

	Fat-soluble A. or anti-rachitic factor.	Water soluble B. or anti-neuritic factor.	Anti-scorbutic factor.
Milk, Cheese, etc.			
Milk, cow's whole, raw	+ +	+	+
,, ,, skim ,,	0	+	+
,, ,, dried whole	less than + +		less than +
,, ,, boiled ,,	undetermined	+	,, +
,, condensed sweetened	+	+	,, +
Cheese, whole milk	+	+	,, +
,, skim	0		
Eggs, fresh	+ +	+ + +	?0
,, dried	+ +	+ + +	?0
Cereals, Pulses, etc.			
Wheat, maize, rice, whole grain	+	+	0
Wheat germ	+ +	+ + +	0
Wheat, maize bran	0	+ +	0
White wheaten flour, pure cornflour, polished rice, etc.	0	0	0
Custard powders, egg substitutes prepared from cereal products	0	0	0
Linseed, millet	+ +	+ +	0
Dried peas, lentils		+ +	0
Pea-flour (kilned)		0	0
Soya-beans, haricot beans	+	+ +	0
Germinated pulses or cereals	+	+ +	+ +
Vegetables and Fruits.			
Cabbage, fresh	+ +	+	+ + +
,, ,, cooked		+	+
,, dried	+	+	very slight
,, canned			,,
Swede, raw expressed juice			+ + +
Lettuce	+ +	+	
Spinach (dried)	+ +	+	
Carrots, fresh, raw	+	+	+

	Fat soluble A. or anti-racbitic factor.	Water-soluble B. or antineuritic factor.	Anti-scorbutic factor.
Carrots dried	very slight		
Beetroot, raw expressed juice			less than +
Potatoes, raw	+	+	
,, cooked			+
Beans fresh (scarlet runners) raw			+ +
Onions, cooked			+ at least
Lemon juice, fresh			+ + +
,, ,, preserved			+ +
Lime juice, fresh			+ +
,, ,, preserved			very slight
Orange juice, fresh			+ + +
Raspberries			+ +
Apples			+
Bananas	+	+	very slight
Tomatoes (canned)			+ +
Nnts	+	+ +	
Miscellaneous.			
Yeast, dried		+ + +	
,, extract and autolysed	?	+ + +	0
Meat extract	0	0	0
Malt extract		+ in some specimens	
Beer		0	0
Honey		+	

Suggestions on Diet.

When generalisations are made from the information now summarized, it will be noticed that they seem in many ways to confirm, and to give a rational basis for ordinary customs in diet. A varied diet is the first necessity. One writer affirms that if this is secured, all that is further needed is some care to obtain material containing fat-soluble A. In varying the diet, too exclusive reliance on tinned foods, patent breakfast or invalid foods or any such preserved and purified foods, should be avoided. Whenever, for any reason, diet has to be monotonous, its aspect with regard to the accessory food-factors should be studied by means of the table above, or by reference to the original sources from which it is taken.

How to secure Fat-soluble A. The most usual reason for monotonous diet is poverty, and concern has been expressed in recent years at the fact that town children of the poorer classes subsist so considerably on white bread and margarine. It is fairly well established that a margarine made entirely from vegetable oils will not contain the growth-inducing and anti-scorbutic food factor. The original oleo margarine made from oleo-oil expressed from beef or mutton fat did contain it. A margarine containing some percentage of this substance, of animal origin, or one made with some percentage of butter, will contribute a small amount of fat-soluble A., and a still smaller amount due to milk for mixing may be present. But any margarine, although as satisfactory a food as butter in its quota of calories, will be inferior to butter as regards the fat-soluble accessory food factor. Therefore, if margarine has to be taken instead of butter, eggs and milk should form part of the diet; or, failing them, a good supply of fresh greens or salads. If the supply of butter, eggs and milk is deficient, children should be given the preference over adults. Though it is true that several races of mankind dwelling in hot climates subsist by obtaining fat-soluble A. from green food only, there can be no doubt that children do better on the much more generally valuable addition of milk. Patent foods for children may require supplementary fat, the addition of milk not giving as much as is suitable. This fat should be carefully chosen to be of the right kind.

A remarkable fact about the fat-soluble vitamine is that it is the only one of which the animal organism seems to have some reserve store. Young animals go on growing for a short time after external supply of this substance has ceased; and nursing mothers are similarly able for some time to go on supplying it to their offspring when it does not exist in their own food. Nevertheless a nursing mother especially should have ample access to sources of all three vitamines, to ensure the proper production of milk.

Water-solnble B. Brown bread is preferable to white bread for use with margarine because of the first food factor being deficient; but it is also better if there is any risk of shortage of the second food factor, as in the use of tinned foods. Care must be taken if over-milled cereals are used to have an ample vegetable and pulse supply, or eggs, either fresh or in the dried form. If there is special difficulty about these, the addition of marmite to the diet will be useful.

Anti-scorbutic factor. In congested town areas raw fruits and salads are often not available for the poorer population; and in certain parts of the world occasional droughts may produce a still worse state of things—no vegetables at all. If the dearth of all fresh vegetable material containing the anti-scorbutic factor is very marked, recourse must be had to dried peas or other pulses which should be set to germinate and eaten in a germinating condition.

If vegetables are used only in a cooked form care should be taken not to overcook, and not to lose the juice. In these conditions the frequent use of a hay-box or any other form of slow gradual cooking for vegetables is to be deprecated. Lastly, the layer under the skin in potatoes should not be thrown away. Apart from its containing most of the nitrogenous content of the tuber, the accessory factors seem to be present in it, as they are present likewise in the outer layer of grains.

* * * * * * * * *

Further Note. A. Table containing the last available qualitative and qualified information on the subject is reproduced from an article by Professor Harden in the Journal of the Society of Chemical Industry, April 1921. It is now more usual to spell Vitamins without the *e*. An article in *Science Progress* (1921) by Miss E. M. Dell on Cooking and Vitamins may be found useful.

VITAMINS OR ACCESSORY FOOD FACTORS.

	A.	B.	C.
Synonyms.	Fat soluble A.	Water soluble B. Anti-neuritic.	Water soluble C. Anti-scorbutic.
Effect of deficiency	Retarded growth ending in death. Eye disease (keratomalacia). Probably one factor in causation of rickets.	Retarded growth ending in death. Beri-beri. Polyneuritis in birds, rats, etc.	Scurvy.

VITAMINS OR ACCESSORY FOOD FACTORS.

	A.	B.	C.
Synonyms.	Fat soluble A.	Water soluble B. Anti-neuritic.	Water soluble C. Anti-scorbutic.
Chief sources.	Animal fats. Fish liver oil. Green vegetables. Egg yolk. Butter and milk. Oleo margarine in proportion to the animal fat.	Seeds, particularly in the germ, pericasp and aleurone layers. Yeast. Egg yolk.	Green vegetables, particularly cruciferæ. Orange juice. Lemon juice. Tomatoes. Germinated seeds. Swedes and turnips.
Present in small amounts.	Oilseeds. Carrots.	Meat. Milk. Potatoes and some other tubers and roots. Green vegetables. Some fruit juices.	Meat. Milk. Potatoes and some other tubers and roots. Many fruit juices. Dried vegetables.
Absent from.	Most vegetable oils. Most lard. Most margarine. White bread. Egg white. Yeast. Purified proteins and carbohydrates.	White bread. Poltshed rice. Fats. Egg white. Purified proteins and carbohydrates.	Seeds. White bread. Fats. Yeast. Purified proteins and carbohydrates.

NOTES ON CHAPTER IV

DIET and dietaries have never, we may be sure, been so fully discussed throughout the world as they were between 1916 and 1920. Their importance in the welfare of nations has called the fullest powers of physiologists, chemists and statisticians to be directed to their problems. Some general conclusions now emerge from international experience and observation; but possibly the effect which will prove to be more important is the change in the methods of stating food requirements and food values. The newer methods will be adopted in the course of this note, and in the note on Chapter VI. The conclusions are taken first.

1. On the whole, the figures, giving in calories various daily food requirements, which were generally accepted before the war, remain valid. Existence can be prolonged on a diet giving a lower fuel value than was believed possible—so much was amply proved in the Central Empires; but the bodily condition then approximates to that of a besieged garrison, and liability to disease is greatly increased.

2. There is a marked tendency among scientific authorities to increase the allowance of food considered necessary for children, particularly adolescents. Compare with the figures on p. 46 the following, quoted on p. 13 of the Summer Report* as having been adopted by the Inter-allied Scientific Food Commission:—

> "Food Requirements: male over 14 years, 1; female over 14 years, ·83; children 10-14 years, ·83; children 6-10 years, ·70; children under 6 years, ·50."

3. The allowance of protein fixed by the earlier workers is usually admitted now to be unnecessarily high. The result of granting that a somewhat lower proportion of protein in the diet is comparable with full health is, that anyone living on an ordinary diet of the usual amount need have no anxiety on the subject of protein. There has sprung to the lips of more than one apologist for this view of a new

* Working Classes' Cost of Living Committee Report, 1918. Cd. 8980. Price 3d.

form of an old proverb:—"Take care of the calories and the protein will take care of itself." There may be a reaction against this deduction from war experience, if years of plenty and cheapness should supervene. But at present most writers seem to agree that it is only when a diet is limited in some abnormal way, or by simple lack of funds, that it will require some trouble to obtain sufficient protein.

4. The diet should be varied, in order to obtain variety in protein, apart from other reasons. Although technical knowledge about proteins has become highly developed and elaborate. there is much still to be known; and it may be long before the result can be used in practical dieting. Each protein is composed of some members of a large group of chemical compounds known as amino-acids, and a large range of these amino-acids must be present in the diet if it is to be adequate for body building purposes. A greatly limited selection of proteins may yield too few of these compounds, or may yield them in wrong proportion. There is safety here in numbers. No distinction in usefulness is made between animal and vegetable proteins in respect of amino-acids. But the practical dietetician has to keep in mind that animal foods rich in protein usually have more flavour and are more appetising to ordinary people than the corresponding vegetable foods.

New methods of presenting figures.

During the last four years new systems for regulating diets in terms of calorie requirements have emanated almost entirely from the United States. This country has had, during those years, the advantage of being still able to supply its people's needs according to scientific standards, although it has practised voluntary economies in food; whereas European countries have rather had to secure the best food they could for their populations, and then ask scientific experts whether it would serve. The new developments are in two directions; first, the systematic presentation of calorie requirements according to the weight and physical position (sitting, standing, walking, etc.) of each individual; and second, the systematic review of all food eaten in terms of calories. The first will constitute the remainder of this note; the second will be a note on Chapter VI.

Recent experimental work has produced many fresh statistics as to the basal number of calorie requirements for an individual of specified weight, sleeping or at rest, and as to the increase in this number

according to the amount of his activity. The basal number of calories, and the increases, are frequently given *per hour*, and the daily calories needed are then calculated according to the occupations of each hour of the twenty-four. Or the calories necessary per 24 hours per oz. or lb. body weight are ascertained and stated. The two methods may be combined, and calories per oz. or lb. per hour stated. Among many presentations of the kind, the schedule given by Mrs. M. S. Rose in "Feeding the Family" have appeared the most suitable for practical use, and they are therefore, by permission, reproduced here.

I. *Men.*

	Requirements in Calories.		
Man lying in bed	·5	per lb.	per hour.
,, sitting up	·6	,,	,,
,, standing	·75	,,	,,
,, walking or light exercise	1	,,	,,
,, at moderate exercise	1·25-1·5	,,	,,
,, at active exercise	1·75-2	,,	,,
,, at severe exercise	3 or more.		

As an example, the daily requirements of a sedentary man weighing 154 lbs. are thus calculated :—

	Calories.
Sleeping, 8 hrs. at ·5 (or $\frac{1}{2}$)	616
Sitting, 8 hrs. at ·6 (or $\frac{3}{5}$)	739
Standing, 4 hrs. at ·75 (or $\frac{3}{4}$)	462
Walking, 4 hrs. at 1	616
	2433

A general summary, distinguishing occupations, runs thus . -

	Calories, per man, per day.		
In bed 24 hours	1600-1800	according to	weight.
At rest, sitting most of the day	2000-2300	,,	,,
Work, done chiefly sitting	2200-2800	,,	,,
,, done standing and walking	2700-3000	,,	,,
Work, developing muscular strength	3000-3500	,,	,,
Work, requiring very severe effort	4000-6000	,,	,,

These figures agree very well with earlier ones, being perhaps a trifle low.

II. *Women.*

The table giving calories per lb. per hour can be used without alteration for women, with their lower body weight. The description of physical position is elaborated thus, mostly for domestic work, by Mrs. Rose :—

Sleeping	·5
Sitting (reading, knitting, writing, sewing by hand or power machine)	·6
Standing	·75
Light Exercise (dish-washing, cooking for 2-4 persons, bed-making, sewing by foot power)	1
Moderate Exercise (cooking for 6-12 persons, sweeping, ironing, scrubbing by hand)	1·25-1·5
Aotive Exercise (cooking for large groups, ironing, scrubbing with heavy implements)	1·75-2

If the average woman's weight is taken as 123 lbs. (this is ·8 of the 154 lbs. above), the calories required by her daily, for moderate activity, will be :—

Sleeping 8 hours	492
Sitting 5 hours	369
Standing 2 hours	185
Light exercise 6 hours	738
Moderate 3 hours	461
	2245

The general summary given, with description of occupations, is :—

	Calories per woman, per day.
At rest	1600-1800 according to weight.
Sedentary work :	
Milliners, Teachers, Bookkeepers, Sempstresses, Stenographers, Machine Operators	2000-2200 ,, ,,
Occupations involving standing, walking, or manual labour :	

	Calories per woman, per day.
Cooks in family groups, General House-keepers, Chamber-maids, Waitresses	2200-2500 according to weight.
Occupations developing muscular strength :	
Laundresses, cooks for large groups	2500-3000 ,, ,,

Protein requirements. These are given as 2 to 2½ calories yielded by protein per day, per lb. body weight. This will be 10-15% of the total calories.* Half a gram of protein yields approximately 2 calories in fuel value, so that the lower limit is half a gram of protein per lb of body weight, 1⅛ gr. per kg., or 79 gr. for a man of 70 kg. weight. 2½ calories per lb. approximates to Voit's 120 gr. These figures may be usefully compared with those given by some Finnish observers in the following table, diets taken by workers at selected trades while under observation in a calorimeter :—

From the work of Becker and Hamalainer, Helsingfors, Finland. (Skandinavisches Archiv für Physiologie, xxxi, 1914) (Taken from Fisher and Fisk ; *How to Live.*

*The following division of calories among the three categories of food is recommended by American writers :—

Protein 10 per cent. (or up to 15 per cent.)
Fat 30 ,,
Carbohydrate 60 per cent.

Bayliss, in England in 1918, suggested as a diet for moderate work :

	Gr.	Oz.	Calories.	Per cent., Calories.
Protein	100	3·75	400	12
Fat	100	3·75	900	27
Carbohydrates	500	18	2000	61
			3300	100

Occupation.	Age.	Height ft. ins.	Weight lbs.	During Rest. Calories per hour.	During Rest. C per hr. per lb. of body wt.	During Work. Calories per r.	Total Calories per day 8 hours work 16 hrs. rest.
MEN :							
Shoemaker	56	5 0	145	73	·50	172	2544
Shoemaker	30	5 8	143	87	·60	171	2760
Tailor	39	5 5	141	72	·50	124	2144
Tailor	46	5 10½	161	102	·63	135	2712
Bookbinder	19	6 0	150	87	·58	164	2704
Bookbinder	23	5 4½	143	85	·59	163	2664
Metal-worker	34	5 4	139	81	·58	216	3024
Metal-worker	27	5 5	130	99	·76	219	3386
Painter	25	5 11	154	104	·67	231	3512
Painter	27	5 8	147	111	·79	230	3616
Joiner	42	5 7	154	81	·50	204	2928
Joiner	24	5 5½	141	85	·60	244	3312
Stone-worker	57	5 11	156	90	·57	408	4104
Stone-worker	22	5 8	141	85	·60	366	4288
Sawyer	42	5 5	167	86	·50	501	5284
Sawyer	43	5 5	143	84	·59	451	4952
WOMEN :							
Hand-sewer	53	5 3	139	75	·54	83	1864
Hand-sewer	35	5 6	143	64	·45	88	1728
Machine-sewer	53	5 3	139	75	·54	103	2024
Machine-sewer	19	5 3	110	64	·58	119	1976
Wash-woman	43	5 3	125	75	·60	285	3480
Wash-woman	19	5 3	110	64	·58	186	2572
Waitress	43	5 3	125	75	·60	228	3024
Waitress	19	5 3	110	64	·58	143	2168
Bookbinder	22	5 4	105	70	·65	98	1904
Bookbinder	22	5 3	112	61	·54	127	1992

Children. The Table following is compiled from the figures given in Mrs. Rose's book for the diets of children at various ages. The needs of each individual child will vary considerably with the height as well as the weight it has attained at the age specified. The child's bodily activity should also be taken into account in fixing the approximate number of calories in its diet. The proportiou of protein is of course of special importance.

Children of age.	Calories per lb. body wt. per day.	Calories in protein per lb.	Total Calories.
1-2	45	4	900-1200
3-4	37-40	3-4	1100-1400
5-7	32-37	3-4	1400-1700
8-9	30-35	3-4	1700-2000
10-12	28-32	3-4	2000-2200
12-13	25-30	3	2200-2600 girls
14-17	20-25	3	2500-3000 boys

The figures may be compared with those of the Inter-allied Scientific Commission already quoted.

Age.		
1-5		1500
6-9		2100
10-13		2500
14	girls	2500
14	boys	3000

Old people. After the age of 70, Mrs. Rose's dietaries suggest 1500 to 1800 calories per day, and for over 80, only 1200 to 1500.

Some recently observed actual diets are subjoined for comparison, both with these theoretical figures and with the list on pp. 49-50.

From Rowntree, *Human Needs of Labour*, 1918.

	Protein grams.	Calories.
British soldier		
Barrack peace rations	133	3369
,, manœuvre rations	151	3812
Active service	140	4190
Average of 12 workhouses, 1914	125	3290
Hollesley Bay Labour Colony, 1914	145	3948
West End Club, 1914	202	5148
Average of thirty working-class families' consumption during 3 weeks of 1915	115	3790

From Report on Diet of Munition Workers, 1918.

	Protein.	Calories.
Hostel dietary, men	90-100	3856
,, ,, women		3070

German diet during the war, as calculated by various scientific authorities.

	Protein gr.	Fat gr.	Carbohydrate gr.	Calories.
German soldier in peace time	120	50	500	3007
,, ,, in 1917	100	67·5	460	2980
Heavy worker, 1917	54	32	336	2050
Very heavy worker, 1917	66	34	438	2400
Maximum worker, 1917	—	—	—	3500
Best civilian diet, 1917	55	28	322	1740
Official rations, 1917	38	13	300	1421
Actual in Dresden, 1917	33	9	140	1217
,, ,, Hamburg, 1917	43	24	—	1650

NOTES ON CHAPTER VI

THE following Tables, A and B, being almost entirely from Mrs. Rose's book on "Feeding the Family," illustrate the new methods of keeping the calorie value of food before the eyes of caterer, cook, and consumer. It will be seen that the task of selecting dishes or planning diets might be made much easier by the use of figures as carefully set out as these are. Notes giving the calorie value of each portion of the various dishes are now used on the menus of certain American restaurants, and likewise on the menus for school dinners at some educational establishments. But, before the reader proceeds to use figures of this kind, it is advisable to emphasise again the warning given on p. 10 of this book, that she must always remember she is dealing with only approximate averaged figures. The amount of variation in the number of calories representing fuel value for any particular food is usually quite considerable. It may be slight for such simple, comparatively pure foods as sugar and tapioca, but it cannot be slight when one is dealing with meat more or less fat, fish more or less watery, or fruit of quite variable sweetness. Moreover the computation of protein content from a determination of the nitrogen content of food is itself based on an average factor, (N x 6·25); 6·25 being used on the assumption that the percentage of nitrogen in "protein" is 16. The actual percentage of nitrogen in different proteins varies from about 15·5 up to 19. Therefore to be accurate, the factor 6·25 ought to change with each kind of protein, which is not convenient under the present methods of analysis. Enough should have been said to make it clear that figures for the number of calories in a cupful of some food, or for the weight of 100 calorie portions, are figures that may always be used with some margin and elasticity. In fact, though very useful as guides, they need not be treated with exaggerated respect.

The use of the word "cupful" reminds us of the difficulties we constantly experience in using measures instead of weights. What are the sizes of the cup and the tablespoon respectively mentioned in these tables? As the corresponding weight in ounces is given in the next column it is easy for the enquirer to find the sizes by experimental trial. American demonstrators seem to avoid the "heaped" tablespoonful as ambiguous, and a *level* spoonful or cupful is used. The cup is stated to be a half-pint one. But the American pint is only ·833 of the English pint; whereas a half-pint cup in England would contain about 10 ounces of water, the cup mentioned in the Table contains about 8⅓ ounces. A cook or demonstrator can doubtless find a breakfast cup about this size, and such a one should of course then be continually used. It should be supplemented by a tablespoon such that 16 fillings fill the cup; (which again seems to be smaller that the average English tablespoon). When the American Tables mention a teaspoon it appears that 3½ fillings make a tablespoon. In England 4 is more usual, but this utensil varies very much in size. However, the reader must make up her mind that if she uses Tables A and B, her cup and tablespoon must correspond to those in the Tables. *Any cup and tablespoon will not do.*

Dimensions of slices are given in inches (″) and portions of inches. There is no ambiguity here.

Table A gives 100-calorie portions of articles of food as they appear at table, described (1) by some approximate volume measure, (2) by weight. The third column is the number of calories in this portion which are supplied by the protein in the food, (*i.e.*, the *percentage* supplied by protein, as the whole portion is 100 calories).

Protein estimated by the calories value.

Yet another preliminary comment must be made on this column. This is not, as are the columns in the original text, protein estimated by weight. It will be seen by reference to the new sort of requirement tables (p.), that a percentage of 10-15 protein *calories* is recommended as a useful form of the criterion for proper supply of protein. This form of criterion is the old "nutritive ratio" used by Hutchison (pp. 36-37) stated as a percentage, not a fraction. The method of calculating this from the weight percentage of protein is given on p. 129. The American Tables for the most part quote, instead of weight, calorie contribution

for the percentage of protein, fat and carbohydrates. Only the protein calories have been transferred to the subjoined Tables here; not only because they are the most important, but also to avoid, if possible, confusion with the weight analyses given in the original text. Thus any food analyses in this book with the headings P. F. C. will be weight analyses; but food analyses giving protein only will be calorie analyses.

Lastly, two more columns are left blank, in addition to blank spaces under the various categories of food, for further data to be collected by the reader.

It is suggested that the comparison of *prices* of the various 100 calorie portions should form the entries in one of the columns. The others might give the demonstrator's own determinations of the right measure to use.

TABLE A

(Taken chiefly from M. S. Rose, *Feeding the Family*).

100 Calorie portions of food as usually served at table.

Kind of Food.	Description of portion in American Units.	Wt. in Oz.	Per cent. of Calories in protein		
Meat, etc.					
Beef roast, rib, lean	Slice $5 \times 2\frac{1}{2} \times \frac{1}{4}$ ins.	1·6	46		
Beef boiled round lean		2·2	90		
Beef corned, fat		1·0	21		
,, ,, tinned		1·25	30		
,, sirloin steak, broiled					
lean	Slice $2 \times 1\frac{1}{2} \times \frac{3}{4}$ ins.	2·0	47		
fat	,, $1\frac{3}{4} \times 1\frac{1}{2} \times \frac{3}{4}$,,	1·3	31		
Veal, roast leg	Slice $2 \times 2\frac{3}{4} \times \frac{1}{8}$ ins.	2·3	71		
cutlets		2·0	30		
Mutton, roast leg	Slice $3 \times 3\frac{3}{4} \times \frac{1}{8}$ ins.	1·2	33		
Lamb, roast leg	Slice $3\frac{1}{2} \times 4\frac{1}{2} \times \frac{1}{8}$ ins	1·8	41		
,, broiled chops	Chop $2 \times 2 \times \frac{1}{2}$ ins.	1·6	40		

Table A—*Continued.*

Kind of Food.	Description of portion in American Units.	Wt. in Oz.	Per cent. of Calories from Protein.		
Pork, steak		·7			
,, ribs roast		·8			
Bacon	4-5 Small Slices	·5	13		
Ham, boiled	Slice $4\frac{3}{4} \times 4 \times \frac{1}{8}$ ins.	1·3	29		
Sausages	$1\frac{2}{3}$ sag., 3 ins. long $\frac{3}{4}$ dia. after cooking	1·1	20		
Capon, roast	Slice $4 \times 2\frac{1}{2} \times 1\frac{1}{4}$ ins	1·7	51		
,, turkey		1·3	40		
Fish.					
Halib't st'k broil'd	Piece $3 \times 2\frac{1}{4} \times 1$ ins.	3	61		
Mackerel broiled		2·6	56		

Table A—*Continued.*

Kind of Food.	Description of portion in American Units.	Wt. in Oz.	Per cent. of Calories from Protein.		
Salmon, tinned	scant ½ cup	1·8	45		
Sardines, ,,	3-6	1·7	46		
Lobster, ,,	¾ cup	4·3	86		
Oysters	6-15	7·2	49		
Shrimps	½ cup	3·2	91		
Soups and Sauces.					
White soups, thickened with starchy material and fat—"cream of."	about ½ cup	about 4 oz.	12-16		
Pea, bean, and lentil soups	⅔-1 cup	6-8 oz.	20-28		
Consommé, bouillon, meat extracts	4 cups	32-34 oz.	84*		
White sauce	¼ cup	2·4	8		
Tomato sauce	5 tbsp.	2.5	5		

* This probably includes all nitrogenous material.

Table A—*Continued.*

Kind of Food.	Description of portion in American Units.	Wt. in Oz.	Per cent. of Calories from Protein.		
Eggs (hoiled)	one large	2·1	20		
,, scrambled	¼ cup	2·1	20		
raw whites	7	6·9	97		
,, yolks	2	1·0	17		
Cheese.					
American	1⅛ in. cube	·8	26		
cream	2 × 1 × ⅜ in. piece	·9	25		
Cream, thin					
18 per cent. fat	¼ oup	1·8	5		
thick, 40 per cent.	1⅛ tbsp.	·9	2		
wbipped	2 tbsp.	·9	2		
Milk					
cond. sweet.	1½ tbsp.	1·1	11		
,, unsweet.	3¾ tbsp.	2·1	23		
whole	⅝ cup	5·1	19		
skim	1⅛ cup	9·6	37		
buttermilk	1⅛ ,,	9·9	33		
whey	1½ ,,	13			

Table A—*Continued.*

Kind of Food.	Description of portion in American Units.	Wt. in Oz.	Per cent of Calories from Protein		
Sugar	2 tbsp. scant	·9	—		
	3½ full size lumps	·9	—		
Treacle	1⅓ tbsp.	1·2	—		
Honey	1 tbsp.	1·1	1		
Marmalade, American		1	1		
Jam, English		1·4	1		
Milk chocolate	2¼ × 1 × ⅛ in.	·7	7		
Ginger, (crystallised)	6 pieces, 1½ × ¾ × ¼ in.	1	1		
Cherries, candied	10 medium	1	1		
Dates	3 or 4	1·1	2		
Figs	1½ large	1·1	5		
Raisins	2 doz. or ¼ cup	1·1	3		
Nuts.					
Almonds	12-15 nuts	·5	13		
Brazil-nuts	2 nuts	·5	10		
Chestnuts	7 ,,	1·5	10		
Filberts	8-10 nuts	·5	9		
Pea-nuts	20-24 single nuts	·6	19		
Pine-nuts	¼ cup	·6	22		
Walnuts	8-16	·5	11		

Table A—*Continued.*

Kind of Food.	Description of portion in American Units.	Wt. in Oz.	Per cent. of Calories from Protein.		
Fruit, fresh.					
Apples	1 large	7·5	3		
Bananas	,,	5·5	5		
Grapes	22 grapes	3·7	5		
Olives	6-8	1·7	3		
Oranges	1 large	9·5	7		
Pears	2 medium	6·3	4		
Pineapple, fresh	2 slices, 1″ thick	8·2	4		
Plums	3-4 large	4·4	5		
Strawberries	1⅓ cups	9	10		
Fruit, tinned					
Apricots	3 large halves and 2 tbsp. juice	4·8	5		
Peaches	2 large halves and 3 tbsp. juice	4·7	6		
Pears	3 halves and 3 tbsp. juice	4·7	2		
Pineapple	1 slice and 3 tbsp. juice	2·3	1		
Potatoes, baked	1 medium	3·0	11		
,, boiled	,,	3·6	11		
,, mashed	½ cup (scant)	3·1	7		
,, chips	8-10 large pieces	·6	5		
Beans, baked, (tinned)	⅓ cup	4·6	13		
Carrots	4-5 young carrots	10·1	10		
Green peas (shelled)	¾ oup	3·5	28		

Table A—*Continued.*

Kind of Food.	Description of portion in American Units.	Wt. in Oz.	Per cent. of Calories from Protein.		
Bread, white	1 sl. $6 \times 3\frac{1}{2} \times \frac{1}{2}$ in.	1·3	14		
Whole wheat	,, $5 \times 2\frac{3}{4} \times \frac{1}{4}$ in.	1·4	16		
Brown	do.	1·5	9		
Rolls, French	one	1·3	12		
Macaroni cooked	1 cup	5·2	15		
Rice boiled	$\frac{3}{4}$,,	4 oz.	9		
Oatmeal cooked	1 ,,	7·9	17		
Butter	ordinary ball or pat. 1 tbsp.	·4	—		
Bacon fat	1 tbsp.	·4	—		
Beef dripping	,,	·4	—		
Margarine (oleo)	,,	·5	—		
Olive Oil	,,	·4	—		
Beverages.					
Cocoa, half milk 1 tbsp, to cup 2 tbsp. sugar	$\frac{3}{5}$ cup	5·5	14		
Chocolate, half milk 1 square to cup 1 tbsp. sugar	$\frac{1}{2}$ cup, scant	4·1	10		

Green Vegetables and Salads. These have not been included in this list. In the former case the 100 calorie portion approaches ¾ lb. for the raw vegetable. The helping of plainly-cooked greens generally served at table may have its calorie value neglected, although its value in other respects must not of course be underestimated. The same may be said of lettuce, celery, tomatoes, etc., in which the 100 calorie portion exceeds 1 lb. American cooked vegetables, as quoted in their Tables, seem to have some addition of fat, and the recipes are not available.

Made Dishes.—These also have not been included. To do so properly the weight of each dish after cooking should be ascertained. Here again American Tables supply figures; but hardly any of their recipes resemble English ones closely enough for the figures to be useful for us. A reader who wishes to work out the 100-calorie portion idea in actual meals will have to calculate for herself the proper quantities or helpings of her made dishes. Table B will be of great assistance to her in making these calculations.

An attempt may be made, however, to give the approximate number of the portions in each helping of certain dishes already analysed in the text.

Dish	100 C. portions in one helping
Stewed Steak	3¾
Toad in the Hole	4½
Hot Pot	3
Fish and Potato Pie	6½
Yorkshire Pudding: Bean Gravy	6¼
Vegetable Hotch-Potch	4
Semolina Cheese	3½
Mock Chicken	3⅔
Suet Pudding	2¾
Sponge Pudding	4¾
Windsor Pudding	1¾
Sago Pudding	2
Stewed Apples	1½
Stewed Prunes	3
Porridge (2 oz. to ½ pint water = one helping)	2¼

The study of the food-value of American made dishes brings out some interesting points. The measurement for quantity of "pie" furnishing 100 calories is a section of a circular pie of 9 inches

diameter. (For this purpose it is certainly very convenient to make circular instead of oval pies.) The section is only 1 inch at the circumference, coming of course to a point in the centre. The ordinary helping of pie will contribute about three times this, one surmises, or 300 calories. A helping of ice-cream must be at least 200 calories as $\frac{1}{4}$ cup gives 100. Samples of home-made sweets or 'candies' are given ; the amount giving 100 calories is from $\frac{3}{4}$ to $\frac{9}{10}$ oz. According to this it would seem that an English girl eating $\frac{1}{4}$ lb. of fancy chocolate has taken 450 to 500 calories ; quite half a substantial meal !

Table B. is planned so as to give figures for the rapid computation of the calorie and protein value of home-made dishes when the measurements are made by cupfuls or tablespoonfuls. The weight of each ingredient is added as a check to the measurement. A demonstrator may, however, find it useful to make a much rougher estimate of the food-value of her mixtures as a simple feat in mental arithmetic. Thus it can be remembered that *very roughly indeed* :—

100 Calories or 1 Portion are contained in—

1 oz. flour, rice, macaroni, cornflour.
$\frac{1}{2}$ oz. (*scant*) of fat.
One egg ; one apple ; one potato.
2 oz. raw lean meat.
$1\frac{1}{2}$ oz. raw fat meat.
$\frac{1}{2}$ oz. fat bacon.
$\frac{1}{4}$ pint milk.
2 tablespoonfuls sugar.

Then, while mixing 1 lb. of flour with 6 oz. suet for a suet crust, one would note there were 16 + 12 portions, or 2800 calories in the crust.

A recipe for apples and rice :—

$\frac{1}{2}$ lb. rice	=	8 portions.
6 apples	=	6 ,,
2 tbsp. = 1 oz. butter	=	2 ,,
2 tbsp. sugar	=	1 ,,
		2500 calories.

Sago pudding :—

pint of milk	=	4 portions.
3 tbsp. = $1\frac{1}{2}$ oz. sago	=	$1\frac{1}{2}$,,
2 eggs	=	2 ,,
2 tbsp. sugar	=	1 ,,
		850 calories.

Table B

(Taken chiefly from M. S. Rose, *Feeding the Family*.)

Material	Measure in American Units	Wt. in Oz.	Total Calories	Calories in Protein	Remarks
Bread crumbs.					
oven dried	1 cup	3½	373	52	
stale	1 cup	3	239	34	
Buttermilk	1 cup	8½	88	29	
Cheese, grated.					
dry	1 tbsp.	⅛	16	4	
,,	1 cup	2	249	65	
fresh	1 tbsp.	¼	31	8	
	1 cup	4	498	130	
Cocoa	1 tbsp.	¼	35	6	
Cornflour	1 tbsp.	⅓	34	—	
	1 cup	4½	459	—	
Currants (dried)	1 cup	5½	502	15	
Egg (whole in shell)		2½	70	25	
1 white		1	14	13	
1 yolk		⅗	56	11	
Flour (wheat).					
unsifted	1 tbsp.	⅓	33	4	
	1 cup	4⅙	459	58	
sifted	1 tbsp.	¼	28	3	
	1 cup	4	395	50	
Macaroni.					
uncooked	10 sticks 9″ long	3½	355	53	
cooked	1 cup of pieces 1 in. long	5⅙	100	15	
Milk (whole)	1 tbsp.	$\frac{7}{10}$	14	3	
	1 cup	8½	170	34	
(skim)	1 tbsp.	$\frac{7}{10}$	7	2	
	1 cup	8½	88	32	
Molasses or Syrup	1 cup	12	976	33	
Oatmeal	1 cup	5½	636	107	
Peel (candied, chopped)	1 cup	2⅘	263	2	
Raisins	1 cup	5	489	15	
Rice (uncooked)	1 tbsp.	½	50	4	
	1 cup	7	696	63	
(steamed)	1 cup	5⅓	127	11	
Suet	1 cup	3½	749	19	
Sugar (brown)	1 tbsp.	⅓	36	—	
	1 cup	5⅓	625	—	
(granulated)	1 tbsp.	½	60	—	
	1 cup	7⅖	840	—	
(powdered)	1 tbsp.	½	48	—	
	1 cup	6	672	—	
Tapioca	1 tbsp.	½	48	—	
	1 cup	6½	640	3	

The following are examples of quickly worked out 'cup' recipes :—

Ingredients.	Calories.	Protein Calories.
Sponge Cake—		
2 cups flour	918	116
2 cups sugar	1680	—
4 eggs	280	100
2 teaspoonfuls baking powder	—	—
	2878	216
White Cake—		
3 cups flour	1377	174
2 cups sugar	1680	—
3 eggs	210	75
1 cup butter	1744	8
1 cup milk	170	34
	5181	291
Nut Cake—		
2 cups sifted flour	790	100
1 cup sugar	840	—
2 eggs	140	50
1 cup butter	1744	8
1 cup milk	170	34
1 oup raisins	489	15
1 cup walnuts	600	68
1 teaspoon cream of tartar	—	—
½ ,, soda	—	—
	4773	275

BALANCED MEALS.

There seems to be a tendency to rather superfluous writing on this subject. A general knowledge of the nature of various foods should be enough for making suitable adjustment or 'balance' in the distribution of proteins, fats and carbohydrates in each meal or each day's meals, without recourse to detailed arithmetic. It would be good practice to study actual meals critically; there are some very useful examples in the Government investigation of the food of

munition workers in 1917.* These examples furnish figures on another point; how many calories should there be in an average good meal? The male munition worker seems to have had about 1000 calories for breakfast, dinner, and supper; 600 or so for tea, making up the daily quota to about 3600. The women's meals varied greatly; they ought to have had about 800 calories in each, excepting tea. A restaurant in America in a girls' high school, which puts on its menus the calorie value of its dishes, prints also at the beginning a direction that food up to 800 calories should be selected for a proper meal. Three such meals would leave a little margin for a tea, a function which does not appear in American daily dietaries.

Returning to the question of balance, gross feeding means usually too large an amount of fat, in pork of all kinds, rich pastry, cream, etc.; and is not likely to be a common error while fats are expensive. Where cost is the first consideration, carbohydrates are likely to show preponderance. During the meat shortage of 1917-18 many people who had recourse to vegetarian dishes were apt to overdo their carbohydrate consumption, from not realising that their meat-substitute was not usually a substance containing only protein and fat, like meat. A made dish of macaroni cheese supplies carbohydrate in the macaroni, and it is quite unnecessary to order a good helping of potatoes and a roll to accompany it, as if it were a slice of meat. One American writer lays it down as a maxim that potatoes, macaroni and rice should never appear at the same meal.

In the same way it is not at all easy to answer the question, perhaps simple at first sight:—What quantity of some other protein-rich food should be substituted for a given quantity of meat? If we aim at the same protein value, we obviously cannot get the same value under the other headings. No two foods are exactly similar or have simple equivalents to each other. The following table, with extraordinarily rough approximate figures, has been prepared. All the foods mentioned except perhaps eggs and milk are subject to large variation in composition. The reader may prefer to make a table of her own; or she may come to the conclusion that such attempts are useless.

* Health of Munition Workers Committee. Memorandum No. 19. Report by Dr. Leonard Hill on Workers' Good and Suggestions as to Dietary. H.M. Stationery Office, B. 10570.

TABLE C.

Equivalents of cooked meat in protein values. Rough guesses only.

Food.	Weight. oz.	P. oz.	F. oz.	C. oz.	Total Calories.
Cooked meat—					
medium fat	4	1 –	1 +	—	400
Eggs	4 eggs	1	1 –	—	305
Cheese	4	1 +	1⅓	—	490
Fish uncooked—					
medium fat	5½	1 –	under ·3	—	180
fat	5½	1 –	under ·7	—	280
Pulses, uncooked	5½	1	1·1	3	525
Nuts (shelled)	5½	1	3	·7	1000
Milk	1½ pints	1 +	1·2	1·5	600

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